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WONDERS
OF ANIMAL LIFE

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CONTENTS OF VOLUME II

CONTENTS OF VOLUME II *(continued)*

Chapter XLIV

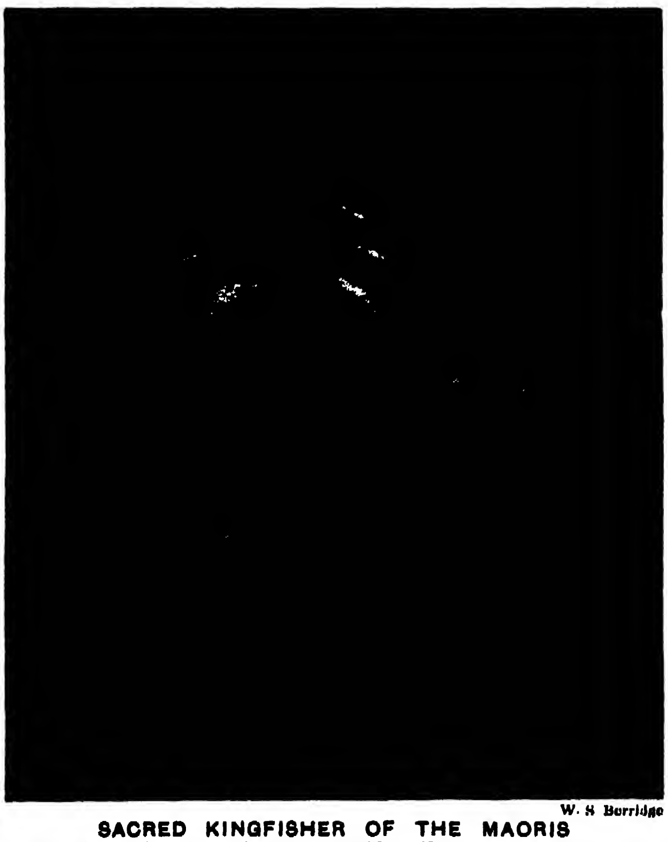
Sacred Animals

By Lewis Spence

Author of "A Dictionary of Mythology"

The worship of animals among the ancient Egyptians, which so greatly amused the Greeks and tickled the risible faculty even of the grave Herodotus, is merely a phase of religious experience through which practically all peoples have passed. That the inhabitants of Britain were no exception to the general rule is clear enough from the statements of Julius Caesar, who, as his own war correspondent, noticed most things during his brief and stormy stay among our ancestors, for he assures us that they refused to eat the hare, the hen and the goose. This abstention from the flesh of certain animals is perhaps the surest sign that they are, or once were, the objects of adoration, or exercised a mysterious guardianship over the tribes who regarded them as unfit for food.

This forbearance from the flesh of certain beasts and birds is associated with the extremely involved system of social taboos and tribal economy which has come to be known to students of savage life as "totemism," a scheme or "way" of life developed throughout long ages of savage experience, regarding the basic principles of which authorities are by no means in agreement. In all probability early man regarded the lower animals as being much on the same plane with himself. He spoke, as do some living savages, of "the Beaver People," or "the Bear People," and in some cases believed that animals distinguished for sagacity or courage were the ancestors of his own tribe or clan. Many legends of such kinship exist, and this supposed actual or spiritual relationship rendered the whole species of the ancestor beast sacred to him. There was a powerful taboo against its slaughter save at certain periods, when it was ceremonially eaten to inspire an access of its qualities.



W. S. Berridge

SACRED KINGFISHER OF THE MAORIS

All kingfishers do not live by the waterside. Here is one which is often seen flitting over the burial grounds of the Maoris of New Zealand. This fine race has for ages held the bird sacred in view of its supposed connexion with the dead and their mystery.

This theory, however, does not account for all the circumstances of animal-worship. At a later stage of totemic belief the beast-form of the guardian or patron animal shaded off into a semi-human form, the body of a man with the head of a bird or beast. But in other cases certain animals were thought of as possessing the symbolic attributes of gods, their wisdom, courage or cunning, and came to be adored as their earthly representatives. It is often extremely difficult to ascertain whether a god originated in the animal form, or whether the animal form merely symbolized the god, and it is only by a careful comparative study of the early forms of the deity as expressed in paintings or sculptures that this can be ascertained. Even so, many cases remain where scanty proof makes it impossible to arrive at any definite conclusion.

It is reasonably clear, for example, that the bull which represented the Egyptian god Osiris was regarded rather as symbolical of his attribute of fertility than as the survival of a totem form, and that the rat which invariably accompanies the Indian elephant-headed god Ganesha, is typical of his sagacity. It seems probable, too, that the owl, represented along with Pallas Athena or Minerva, was characteristic of the wisdom of that goddess rather than reminiscent of any more primitive form of her, even though Homer does allude to her as "the owl-eyed Athena."

Ancient Egypt was perhaps more rich in sacred animals than any other country of antiquity — the bull, the serpent, the cat, crocodile, ape, hippopotamus, ibis and dog, scorpion and frog all figured in her animal pantheon. The sanctity with which these animals were regarded may, in some instances, have been a legacy from totemic forms of worship, but,

W. S. Berridge

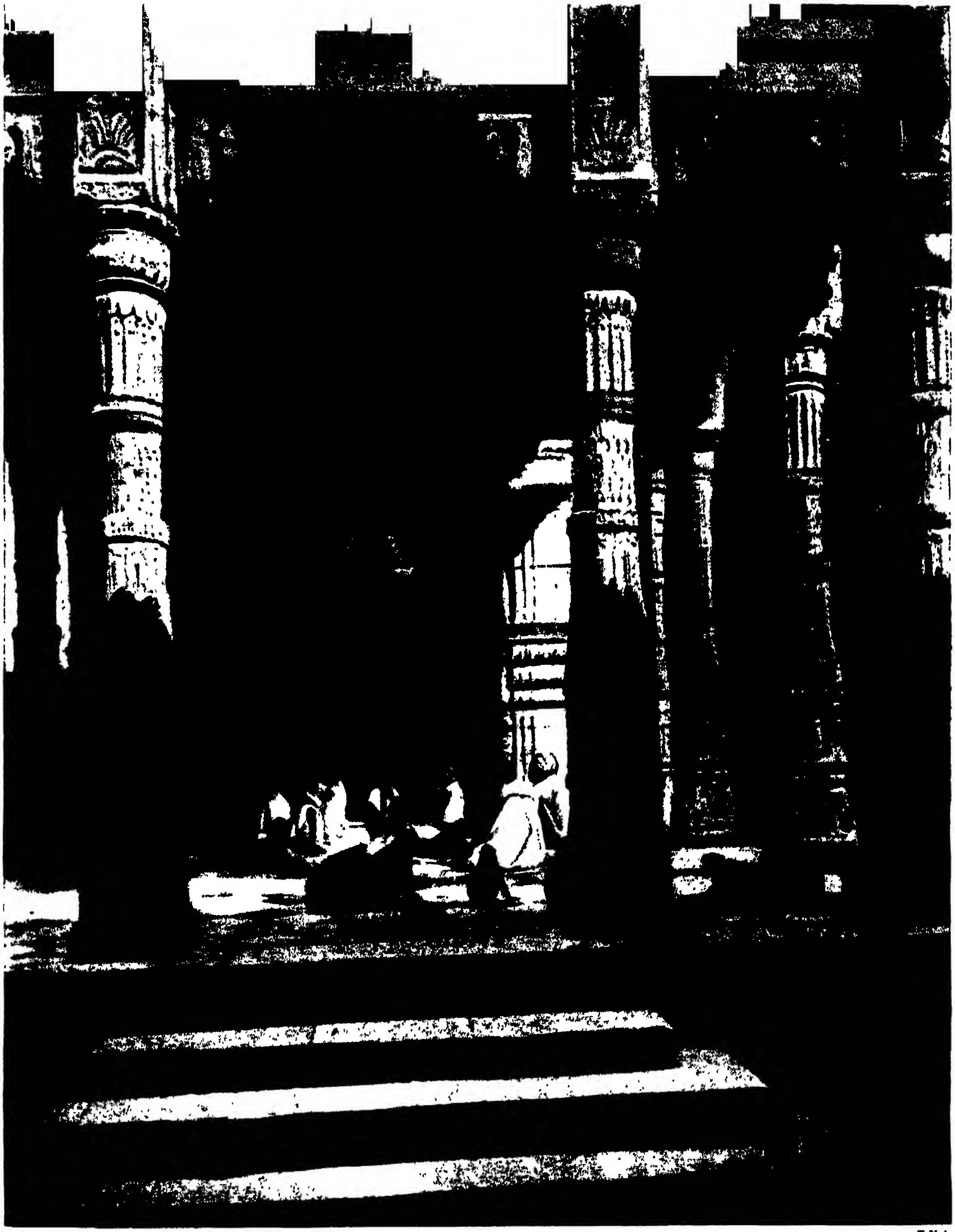
IBIS, THE BIRD ROUND WHICH THE EGYPTIANS MADE A CULT

One of the most important religious cults in ancient Egypt was the cult of the ibis, which is a bird of the crane species. It was associated with the deity Thoth and with the moon, and was supposed to meet and kill certain terrible winged snakes which were said to invade the land each year from Arabia. Indeed, Herodotus, the great Greek historian, who has preserved so much of the myths current in his time, says that there was believed to be a gorge at the mouth of which the ibis mounted guard, there to slay the snakes as they flew past.

be that as it may, they were adored in one or other of the provinces of the Nile country either as local patrons, or personifications of the gods. When they died they were mourned for as if they had been human, and were embalmed in the same manner as the dead Egyptian.

The cult of the Apis bull in Egypt is traceable to early dynastic times Careful search was made for him as a calf, for he must bear the prescribed marks of sanctity. He must be jet black, with a square, white blaze on the forehead, the figure of an eagle on the back, double hairs in the tail and the outline of a beetle on the tongue. When found, he was placed on board a barge in a gilded cabin and transported by water to Memphis, where he was installed in a gorgeous shrine, given rich beds to lie on, fed with the most delicate food, and supplied with water from a sacred well. As a general rule, he was kept in strict seclusion, but on certain festal occasions he appeared in public, surrounded by priests and chanting choristers. His birthday rejoicings alone lasted for seven days every year. As an oracle the sacred animal enjoyed the most extraordinary celebrity, and distinguished strangers in Egypt seldom neglected to visit his temple. When the Apis bull refused to eat from the hand of Germanicus that conqueror's speedy death was prophesied, and the conquest of the Nile land by Augustus was supposed to have been foretold by his bellowings. On his death the Apis bull was embalmed and buried in the Serapeum at Memphis, and the most elaborate funerary rites were observed, a sarcophagus nearly sixty tons in weight being provided for his last resting-place. When defunct he was supposed to become one with Osiris, and took the form of Osiris-Apis, or Serapis, as it was known to the Greeks, a deity whose cult found its way to Rome, and ultimately to Britain, where he had a temple on the site of the present York Minster. At Heliopolis another sacred bull, Mnevis, was worshipped with equally elaborate ceremonial.

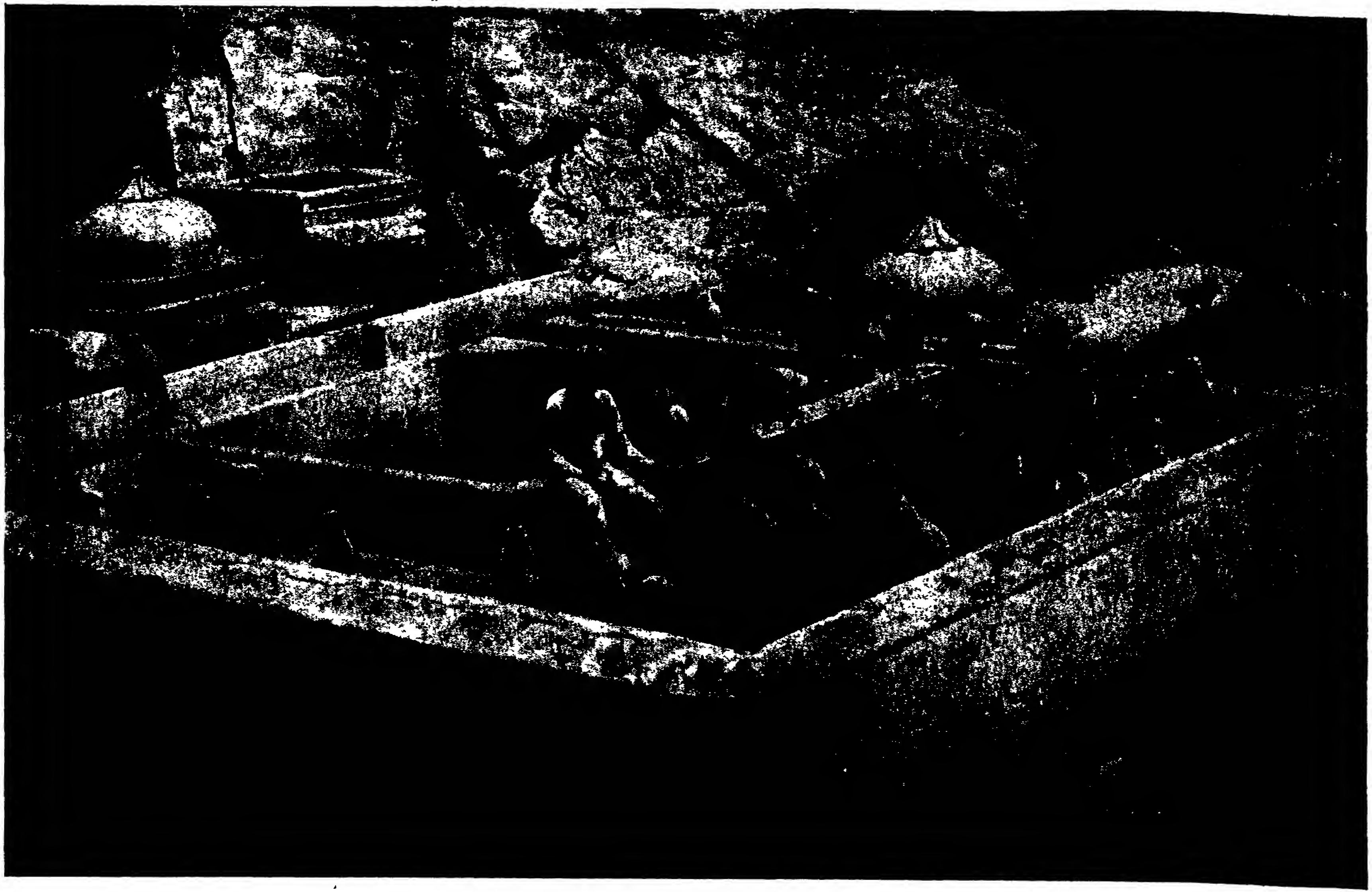
At Mendes, Hermopolis and Lycopolis the sacred ram associated with Osiris and Ra was worshipped, and this animal also bore specific symbols of deity. The crocodile was regarded as the incarnation of the god Sebek, and its propitiation was secured during the dry season by permitting it to wander at will



E.N.A.

MONKEYS UNDISTURBED IN THE HOLY PRECINCTS OF A TEMPLE IN BENARES

Benares, the great Indian city on the Ganges, is one of the most holy places of the Hindus, and thousands of pilgrims go there every year. This is one of the many temples and with the worshippers crowds of monkeys mingle, secure of food and safety within the sacred precincts. Animals have always played an important part in the drama of the Hindu pantheon, not as symbols of the gods, but because certain beasts are regarded as having acted, at one time or another, as the bodily regenerations of the gods.



E.N.A

SACRED MONKEYS BEING FED ON THE ROOF OF A HILL TEMPLE IN INDIA

This temple stands in the Galata Pass, and is built at the foot of a rocky hill. The monkeys come down from the heights above to receive a regular ration of food, which generations of thi practice has led them to expect. We see one of the guardians of the place feeding the little creatures on the roof in the blazing sunshine. They are considered as being under the protectior of the being worshipped at this shrine, and are safe from men. But there is a good deal more of habit than of religious fervour in all this, for animal worship, as such, has greatly deteriorated ir India from the tremendously powerful and extremely widespread institution that it once was.

W. S. Berridge

EGYPTIAN CAT SAID TO BE THE INCARNATION OF THE SUN GODDESS

At about the time of the Twenty-Second Dynasty, nearly a thousand years before Christ, the cult of Bast, goddess of the sun, seems to have arisen in Egypt. The animal associated with her and regarded as her incarnation was the cat and so this animal was held to be particularly sacred. Death was the only punishment that fitted the crime of killing a cat, and there is a record of later years when a foreigner, a Roman, was unfortunate enough to kill one, and was lynched by the crowd. This particular animal is the Egyptian or fettered cat

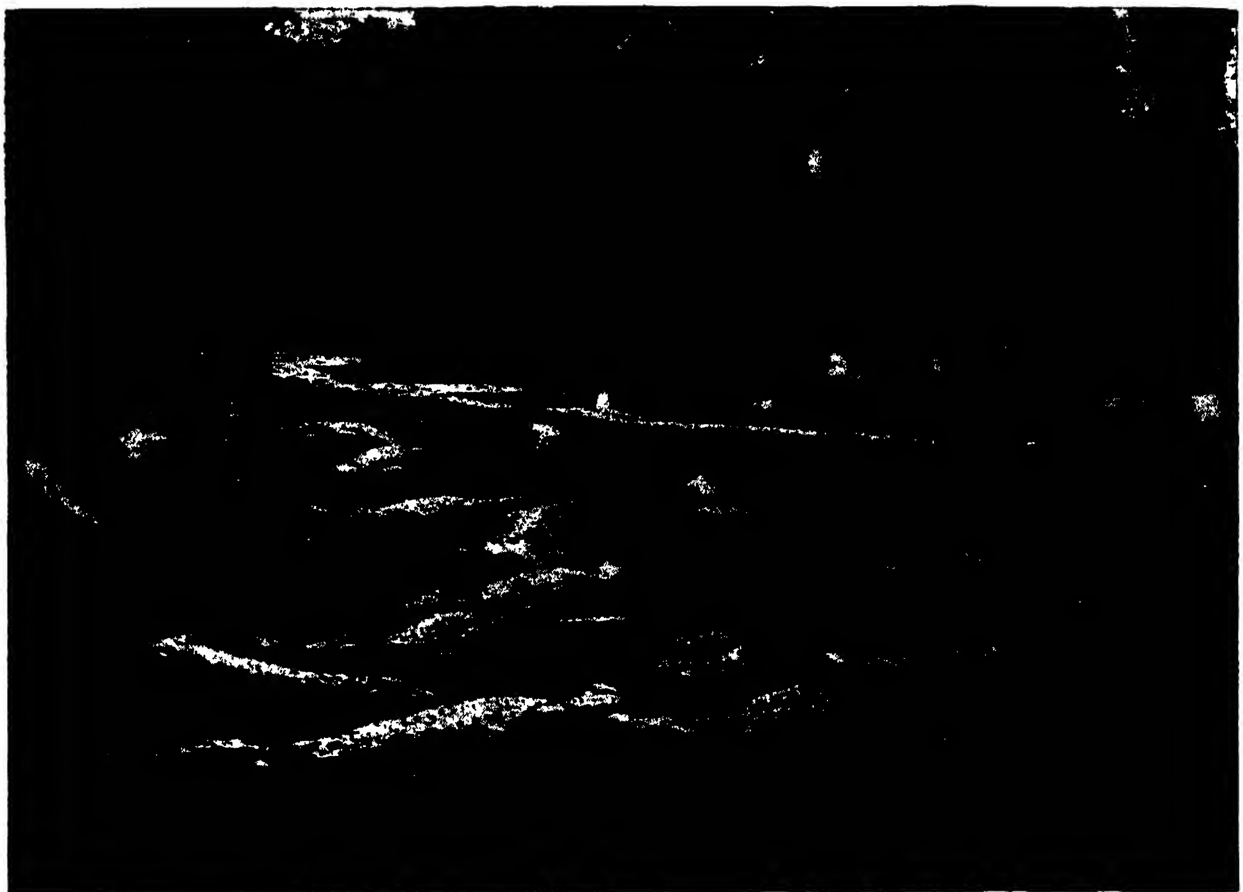
over the cultivated lands, devouring any living thing which chanced to come in its way. It was believed to be the tutelary god of the dead, who restored to them the functions enjoyed in life. On the banks of Lake Moeris the crocodile was regarded with special sanctity, people bedecked the tame saurians in these waters with jewels and fed them on the choicest foods. After death they were buried in a subterranean labyrinth, and Strabo, who visited Egypt during the reign of Emperor Augustus, provides us with an interesting account of the manner in which the tame reptilian representatives of the god were pampered by the priests of the cult, who fed them with cakes, honey and wine.

At Leontopolis in the Delta, lions were worshipped as the presiding animal guardians, and were fed upon live calves, which were thrust into their dens so that they might have the savage joy of killing them, and thus be kept in a propitious mood. These beasts were identified with the guardian god Aker, who was supposed to keep watch over the gates of dawn, and his sacred lions, Sef and Dua, "Yesterday" and "To-day," were thought of as guarding the portals of the past and the present.

But no animal received a greater meed of popular adoration than the harmless necessary cat, which was regarded as an incarnation of Bast, the goddess of the sun. Her cult appears to have arisen somewhere about the period of the Twenty-second Dynasty (954 B.C.), and for her sake all cats in Egypt received particular veneration and protection. Death was the penalty among the Egyptians for killing a cat, even by accident, and a Roman who had done so was lynched by the infuriated populace. When dead, cats were carefully mummified, and, says Herodotus, buried in the city of Bubastis, the town of their patron goddess.

The hippopotamus was the animal representative of the goddess Ta-urt, who, though protective and benevolent, still retained her original traits of ferocious destructiveness. The dog-headed ape, or cynocephalus, was also greatly revered by the Egyptians, and apes were kept in many temples, especially in those of lunar deities, as that of Khensu, at Thebes, and that they were in some manner associated with the moon there can be no doubt. The jackal was sacred to Anubis, the guide of the souls of the dead through the Underworld, a connection which probably arose through the haunting of burial-places by that animal, but the serpent was perhaps more feared than venerated. The frog seems to have been worshipped as the symbol of fecundity, and his was certainly one of the oldest cults in Egypt. The goddess Heqt, identified with the cow-headed goddess of the sky Hathor, the Great Mother, was depicted with the head of a frog.

A cult of great importance was that of the ibis, a bird of the crane species, associated with Thoth



A.N.A.

CROCODILES OF KARACHI CRAWL ACROSS THE MUD TO BE FED

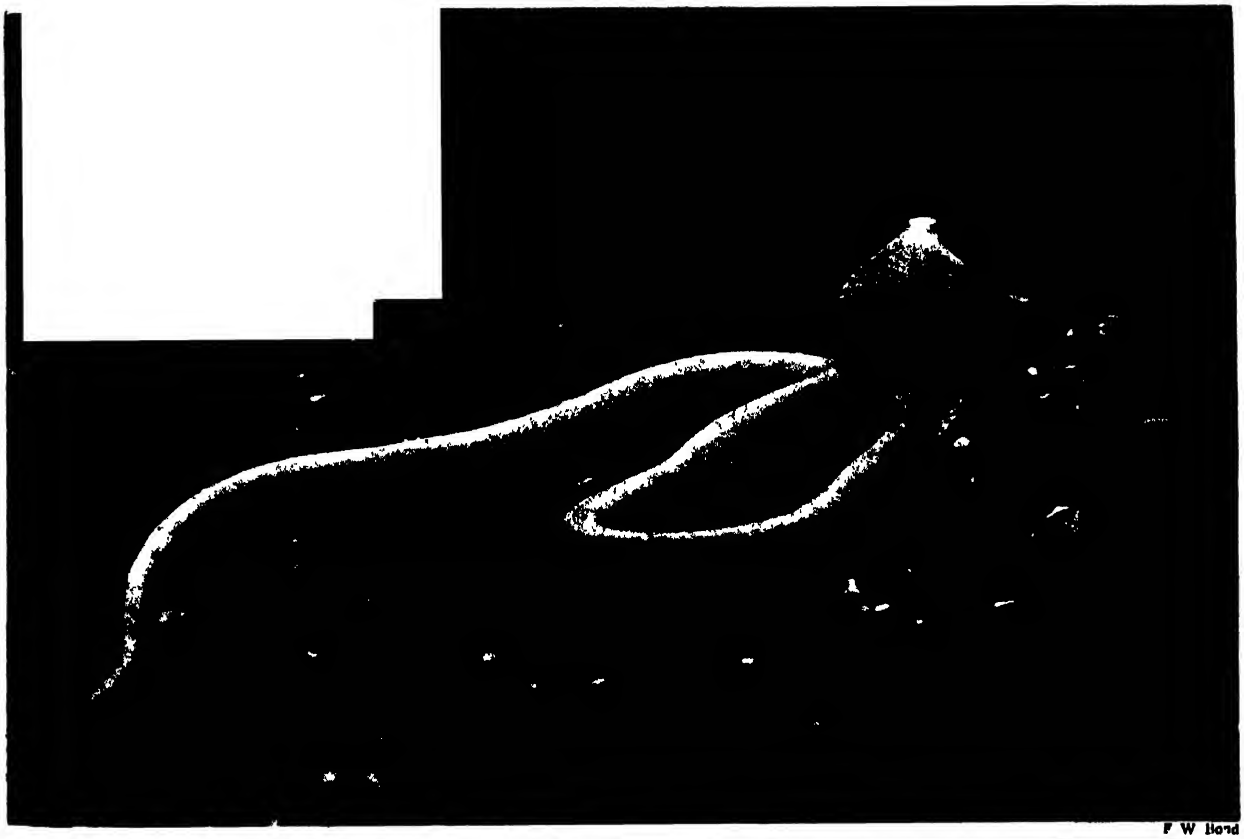
This is the famous "mugger" pit at Karachi. It consists of a muddy pool about three hundred yards round, and out of the water grow tufts of dank grass making little islands on which the great, repulsive saurians lie basking. In the photograph we see the ugly crew coming out of this tepid swamp across the warm ooze to where one of the keepers waits with food for these well tended monsters. In olden days the crocodile was also regarded as sacred in Egypt and sacrifices were made to it.

and the moon, and the nucleus of this worship centred at Hermopolis. The ibis was chiefly venerated as the destroyer of serpents, and was believed to meet and slay the mythical winged snakes which were supposed to invade Egypt from Arabia Herodotus tells a weird story of how the ibis in the spring season takes its stand at the mouth of a gorge through which the winged snakes fly, barring their entrance and killing them.

THE bennu, a bird also not unlike the crane, was identified by the Egyptians with the mythical phoenix, which was believed to seek out a funeral pyre once in five hundred years, from which it arose in the plenitude of vigour, to live for another five centuries. It was, of course, a symbol of the deathless nature of the sun, re-arising from the fires of dawn. The falcon was also sacred to Ra and Osiris, the bird of the sun and of the regenerated human soul.

The worship of animals continued unabated during the Hellenic period. It is even probable that this phase of the Egyptian religion had become more pronounced under Greek rule, for Strabo, writing in the time of Augustus, asserts that statues of sacred animals had practically displaced those of the gods. The sacred ram (Khnemu) of Mendes was worshipped both by conquered and conquerors, as was the Apis bull and the sacred crocodile, and it would seem that the temple revenues were at times increased by displaying these animals to the curious gaze of strangers. The European Greeks, however, retained their contempt for the Egyptian custom.

I have alluded to Caesar's mention of British sacred animals. Many such must have been worshipped. Several of the British clans were called after animals, such as the Bibroci of South-Eastern Britain, who seem to have been a beaver-worshipping tribe, or the Clan Chattan of Scotland, "the People of the Cat." The Keltic goddess Epona seems to have been developed from an equine form, and the Irish hero-god Cuchullin from a bull, just as the Indian god Indra is developed from that animal, as was Dionysus or Bacchus in Greece. But the question of animal worship in Britain is much too obscure to permit of dogmatic statement, and it is plain that at the period when the native religion of the Britons was first brought under Roman observation it had long surpassed the first primitive stage



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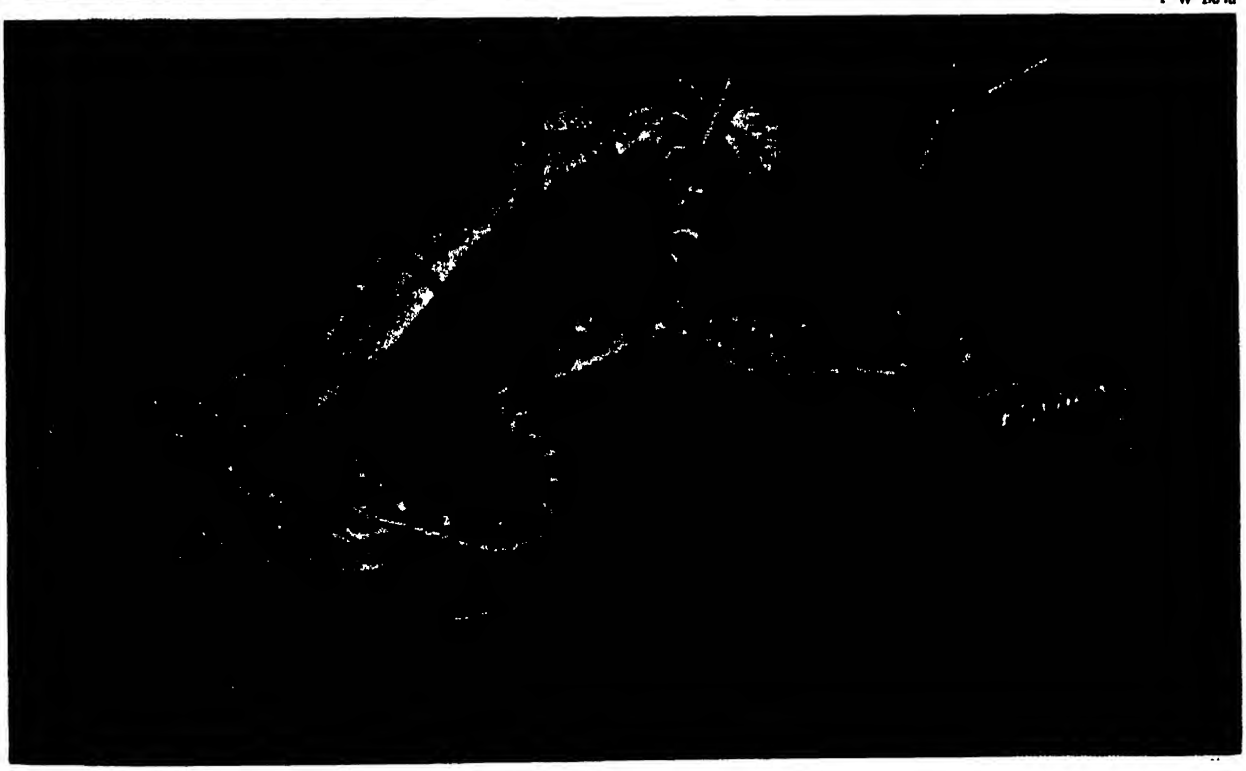
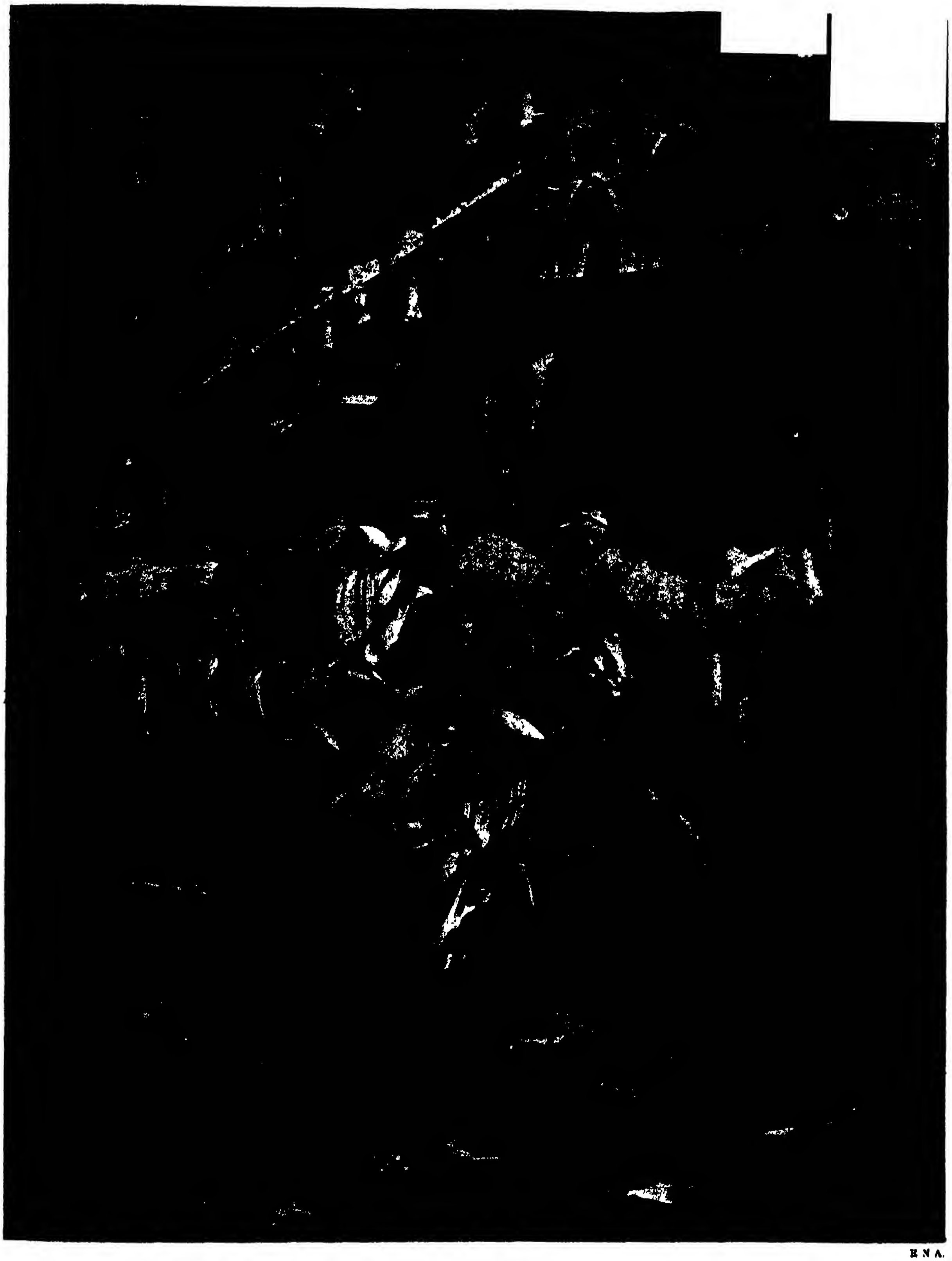


SNAKES WORSHIPPED IN A TEMPLE OF PENANG AND A WHITE COBRA

In the temple of the snake god of a village near Georgetown, Penang (bottom), there are branches stuck into pots before the shrine and among these branches many snakes cling drowsily, or writhe and glide amongst each other's coils. These snakes are fed upon eggs delivered to them in baskets, nor do they ever harm their attendants or the worshippers in this temple which they never leave. The upper photograph shows one of the rare white cobras of India, which are held to be sacred.

SACRED ELEPHANT WITH ITS ATTENDANT OUTSIDE A TEMPLE OF MANDALAY

Here is a young elephant which is kept in the grounds of a temple in Mandalay, Burma. In this country certain light-coloured elephants known as "white" elephants are often called sacred simply because they are used for state purposes, automatically becoming royal property as soon as they are born. Being kept apart for processions and occasions of pomp only they have become associated with the purpose of such pageantry when it was in use for religion's sake. These elephants' prestige was also added to by their being royal.



B N A.

CATTLE ENJOYING THE RIGHTS OF SANCTITY IN CALCUTTA STREETS

Hindu feelings are very strong on the question of the sacred humped cattle. At whatever cost to human inconvenience these creatures are allowed to wander at will through the bazaars and streets, the police being bound to support the custom. Hence we find, in a great city like Calcutta, such sights as this, where a pavement built after the western fashion is encumbered by a number of cattle placidly chewing their cud as though the street belonged to them. Pedestrians have to step into the roadway to pass them.

E.N.A.

WORSHIP FOR A COW IN THE STREET

Such a scene as this is not uncommon in the holy city of Benares. A Hindu woman has stopped to put up a prayer beside the indifferent looking cow which, to her, is a symbol of divine things. In Benares devotions come before traffic convenience.

of totemism, and had preserved only a few reminiscences of the direct adoration of animals.

The sacred animals of India are revered not as in Egypt, as symbols of the gods, so much as the possible reincarnations of human beings whose souls have entered their bodies in the process of transmigration. To the Buddhist all animals are inviolate, and the life of even the smallest insect may not be taken without offence. But in the Hindu pantheon certain animals are regarded as having at one time or another acted as the avatars or bodily regenerations of the gods, and have thus an especial sanctity. All cows possess a certain degree of sacredness because of their former association with Krishna, the divine cowherd, the elephant because of its symbolical connection with Ganesha, the god of knowledge, and the serpent, whose affinities are with the cloud-gods, is also venerated, or rather feared. But animal worship in India has greatly deteriorated since early times and seems steadily to decline under the later dispensations of Hinduism.

Some of the aboriginal tribes of America are still in the totemic stage of religious belief, and there is abundant evidence that certain of them anciently worshipped animals, directly or symbolically. Many of the North American and some of the South American tribes believed and still believe, that the various species of animals, deer, birds, fish, and so forth, are governed by a divine Great Deer, a Great Turkey, a Great Fish, who send their subjects as food to man, but who must be placated before or after these are killed. For example, among the Zuñi of New Mexico the deer god must have his lips smeared with the blood of the slain deer immediately after it is shot. This notion throws considerable light on the origins of animal deities as a whole, and it may be that the idea of animal gods as great food-senders or producers accounts for the creation of certain classes of such deities in the savage mind, though it certainly cannot account for those which were not of a food-giving character.

Specific animals were also venerated in Old America because of the fear they inspired. The Creek Indians worshipped the alligator, and never destroyed one. The jaguar was adored by the Moxis of Bolivia, who appointed as priests those who had escaped from its claws, and by the Maya and Quiche of Central America, who on meeting a jaguar in the forest calmly knelt down and awaited their fate, considering it blasphemous to attempt to slaughter the beast. The mysterious anti-Christian cult of Nagualism, which still lingers in the remoter parts of Mexico and Central America, is based on the belief that each individual has a beast as a patron or personal guide and familiar.

The ancient Mexicans and Maya also worshipped Camazotz, the bat, as a god of the Underworld, affixing his head to a human body in precisely the same way as did the Egyptians with the jackal or the ram. The caves in which bats lurked were regarded as places of the utmost sanctity, and their inmates were never disturbed. The civilized Incan Peruvians, on conquering the barbarous province of Huanca, in pre-Spanish times, were disgusted to find temples raised to the worship of the dog as the highest form of deity. To this canine Jupiter the priests offered up fatted representatives of his own species, and afterwards devoured them. Many of the wild tribes of the Pacific Coast united in the adoration of the coyote, of whose doings and adventures the most extraordinary tales are recounted in the myths and legends current among those people.

Besides these, the owl, the frog, the tortoise and many other animals were worshipped in Old America, and among the coastal Peruvians even the shark was regarded as divine, these creatures being thought to possess special attributes of wisdom, fertility or courage.

Some animals commonly referred to as "sacred" are so described merely because they are employed for especial or state purposes. For example, the royal white elephants of Burmah were frequently alluded to as "sacred elephants," but were used exclusively for processions and galas, and for that reason were kept apart, and this, in all probability, is the reason why they were regarded as partaking of the divine. The doves of Venus, held in such sanctity by the Romans, among whom to kill one was regarded as a dreadful misdemeanour, are an example of another class of "sacred" animals devoted to a god or goddess because of some fancied resemblance in temperament. Such, too, were the mice of Apollo, the leopards of Bacchus, the eagle of Jove and the ravens of Odin. In Britain, too, we find examples of this sort of thing. A Briton, says the old chronicler, will never kill a crow, for it is believed by our ancestors that the great King Arthur on his death took the form of one of these birds—pretty sure evidence that they were in some manner associated with his cult as a British deity.

Chapter XLV

British Reptiles and Amphibians

By Gerald Leighton, M.D., D.Sc.

Author of "British Serpents"

These two groups of vertebrates, for some reason not easy to understand, are frequently associated together in the popular mind. As a matter of fact, they have not very much in common, except that a large number of people have a considerable repugnance to both. From the point of view of the zoologist the reptiles are more closely related to the birds than to the amphibians, while the amphibians are nearer to the fish.

One important characteristic, however, is common to amphibians, reptiles and fish, and that is that all three groups are cold-blooded. The temperature of their blood is that of their immediate environment, whether that be water or air, varying with it. This dependence upon the environment for warmth is closely associated with the varying seasonal habits of the species concerned. Thus, the condition of hibernation, which is referred to later, is obviously an attempt on the part of the cold-blooded animal to withstand the rigours of the winter in cold or temperate climates. As far as the British Isles are concerned the species are few, small and, with the exception of the adder or viper, absolutely harmless.

The reptiles have certain characteristics common to all of them. Besides being cold-blooded they have an external covering which differs entirely from that of either mammals, birds, or amphibians. All reptiles are covered with scales of a hard or horny nature, as in the snakes and lizards, or in the form of plates such as are seen in the turtles. Associated with the cold condition of the blood is a very simple breathing apparatus as compared with birds or mammals, and in all reptiles the breathing takes place through lungs throughout the whole life.

As regards reproduction, in all reptiles fertilisation is internal and in most cases results in the deposit of eggs. Some reptiles, however, carry the young until they are fully developed, when they rupture the egg-membrane and escape alive. In this case the reptile is termed ovo-viviparous or viviparous, as opposed to oviparous or egg-laying species.

There are many other anatomical details characteristic of reptiles, recognized only by the expert anatomist, of which we may mention the blood corpuscles. In reptiles the red cells of the blood have a nucleus, they are oval in shape and biconvex, characters which separate them sharply from the blood of mammals. The skin covering differentiates them from birds, as does the structure of the heart. From the amphibians they differ in never having gills in early life, and also in many characteristics in the bony skeleton.

RARE SMOOTH SNAKE

In Dorset and the neighbouring counties the handsome smooth snake or coronella is occasionally found. A careless observer might mistake it for an adder and this mistake often causes the destruction of this already rare and quite harmless creature

The grass snake or ring snake (*Tropidonotus natrix*) is by far the most numerous of English snakes, but is practically absent from Scotland and unknown in Ireland. It is abundant in Wiltshire, Gloucestershire, some Welsh counties, and many parts of the South, the Cumbrian mountains marking its northern limit somewhat abruptly.

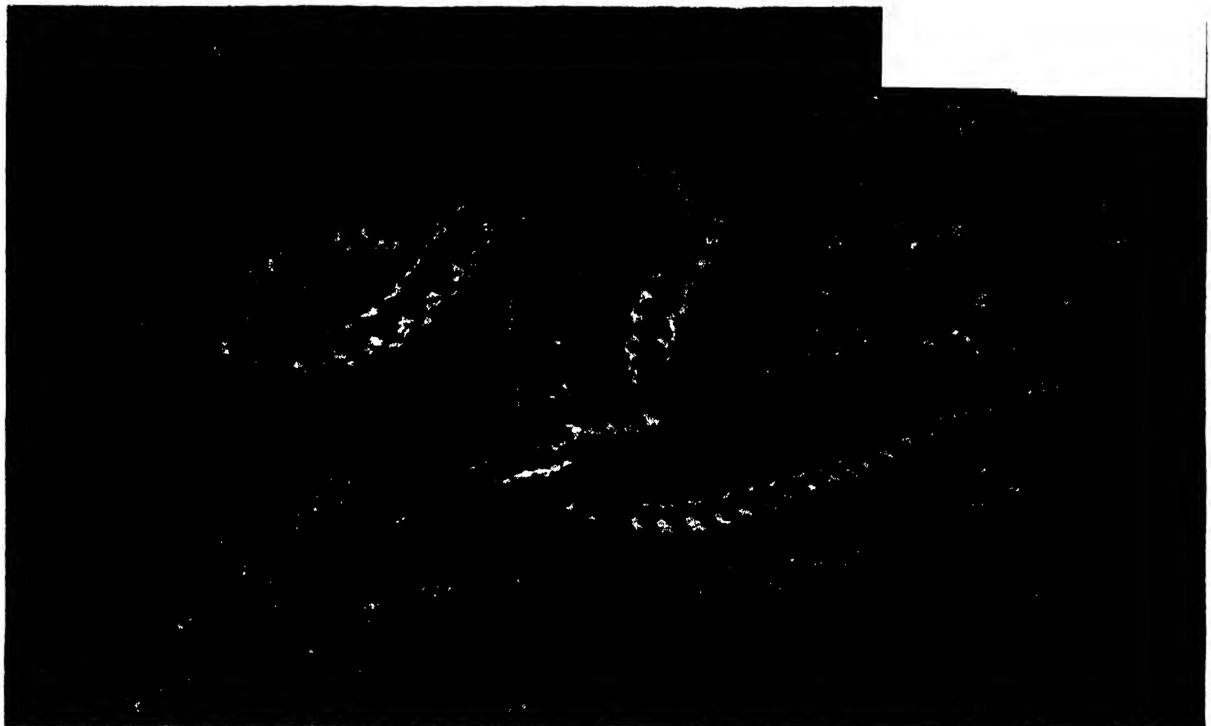
It is by far our largest reptile. The average adult length is from thirty to thirty-six inches, but much larger specimens are not rare. Any snake over thirty inches long in this country may safely be diagnosed as a grass snake. It is thinner and more attenuated than the adder, the tail tapering off gradually, whereas that of the adder is short.

Grass snakes are fond of water and are usually found in its neighbourhood. This is associated with their favourite food, namely frogs. The frog is seized by one hind leg, which is gradually swallowed, and then the snake slowly gets the body of the frog into its distended jaw, at which stage the other three legs and head of the frog project forward in a very curious picture. Birds, mice and eggs are also eaten. The snake is an expert swimmer.

The young are produced from eggs which are deposited in some warm spot, often in manure heaps or garden rubbish. They are deposited in bundles which adhere together, each bundle containing on the average nearly thirty eggs.

This snake is often called the ring snake from the yellow collar on the neck by which it is readily distinguished. The general body colour is olive green, darker above, shading off into a greenish yellow on the sides, the belly being dark bluish black. There are two rows of irregularly-shaped black patches, one on either side of the long body. The young are dark at first but soon develop the colours, and in a few weeks the yellow collar is quite brilliant in appearance.

The grass snake is an interesting pet, being docile and perfectly



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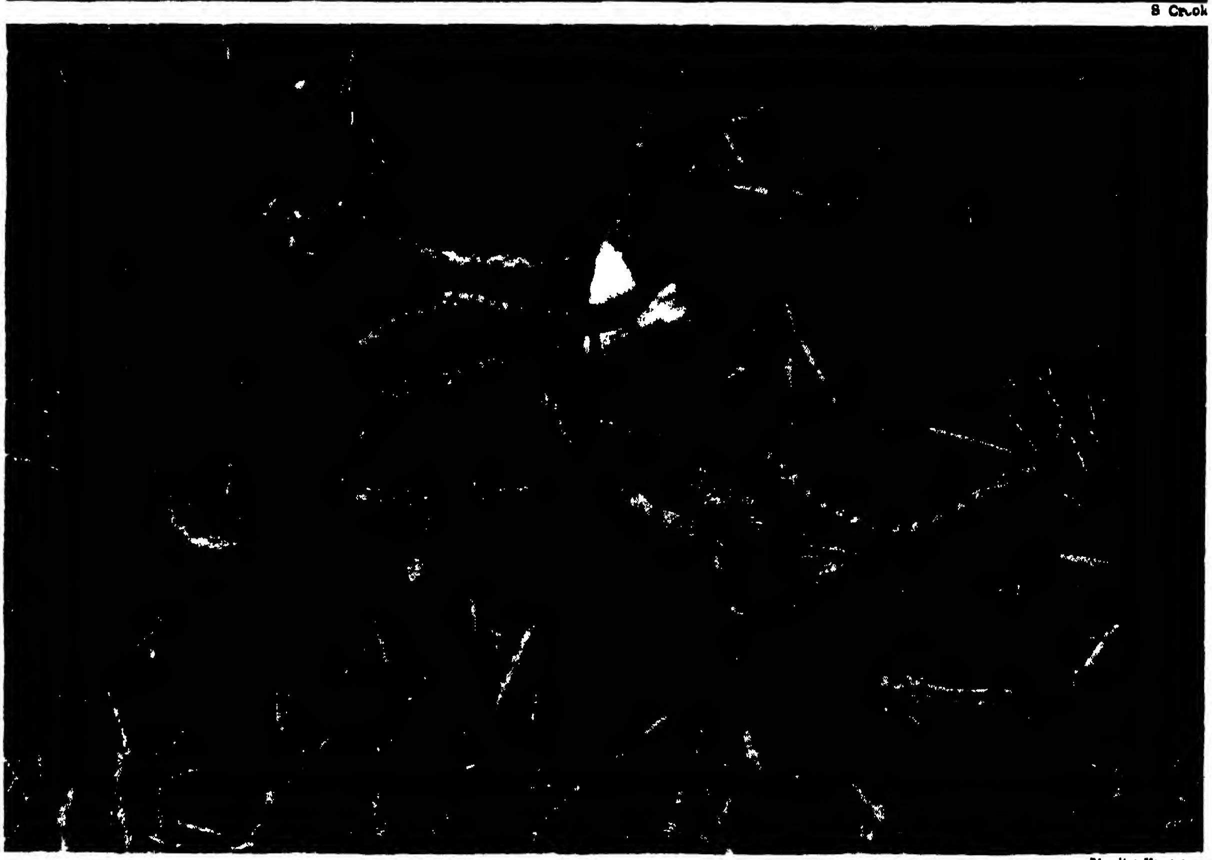
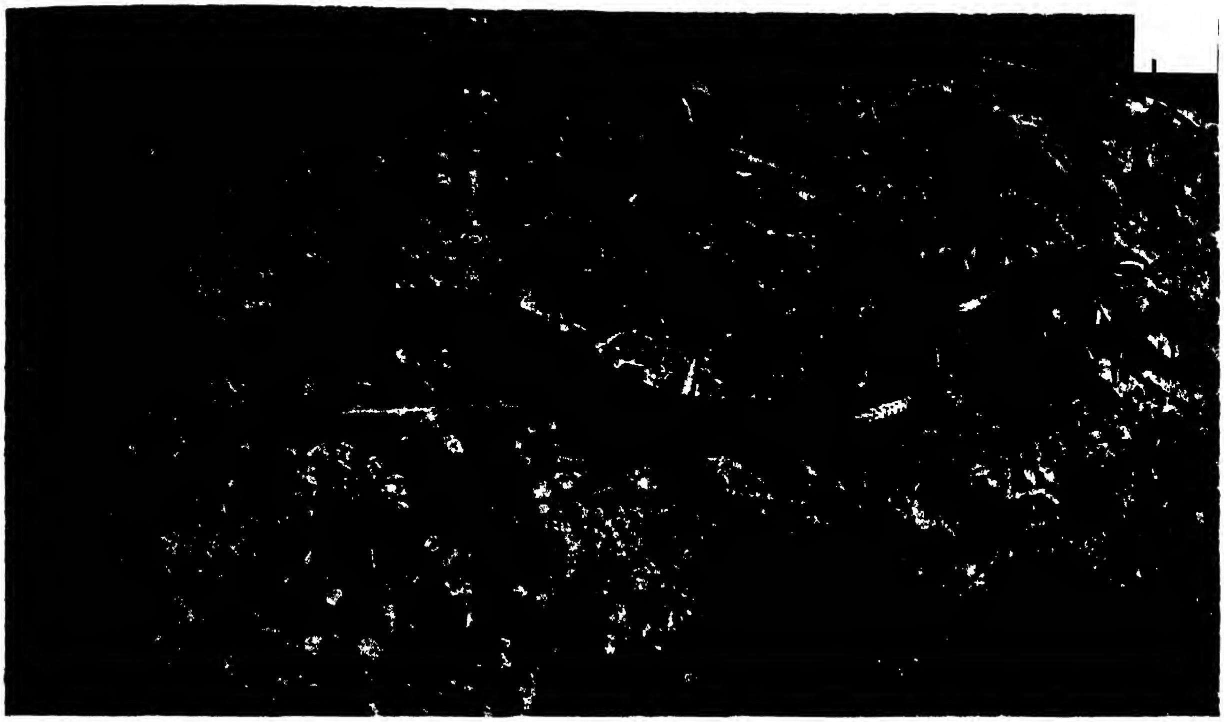
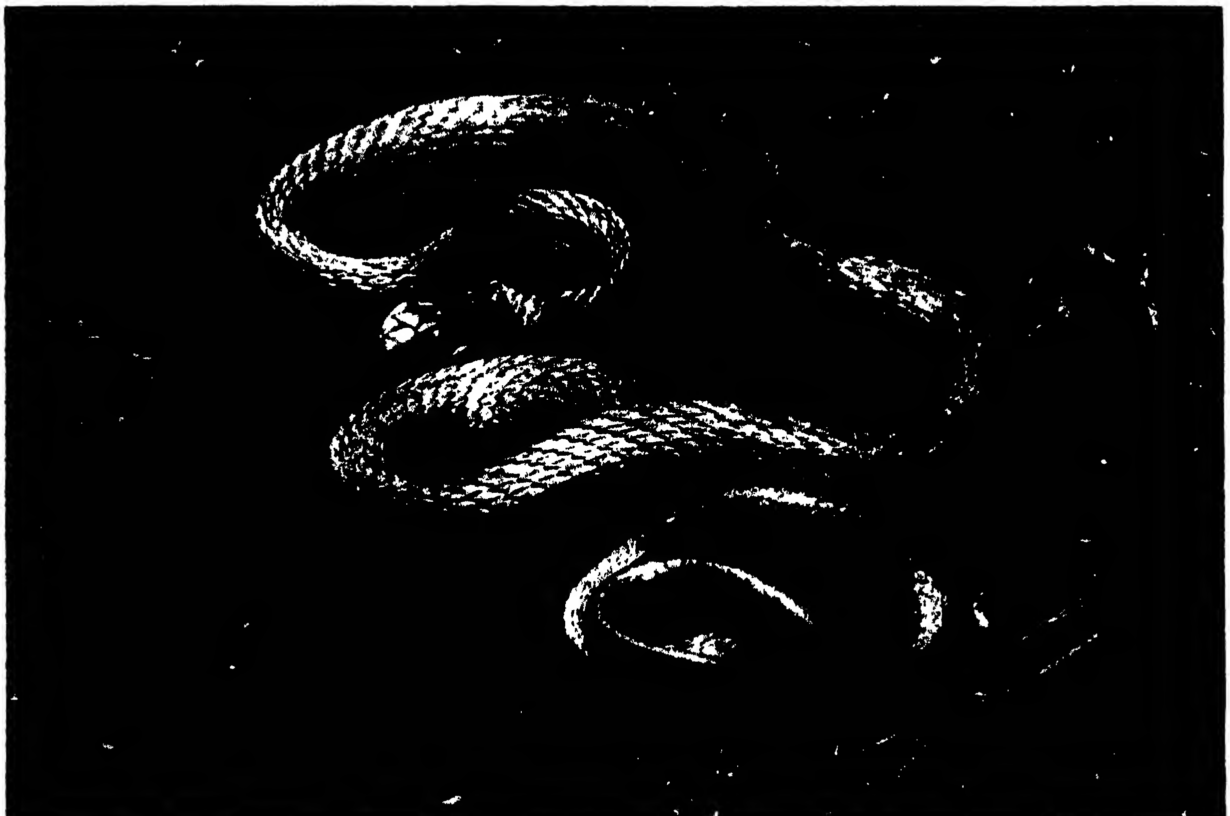


Neville Kingston

ADDERS, THE ONLY VENOMOUS SNAKES OF BRITAIN

Britain's single poisonous snake is the adder or viper and it may be told by the "V"-shaped mark upon its head, which is shown up by the light bordered portion of the skin just behind it. Down the back runs a zig-zag dark line. Adders prefer warm sandy places and are harmless enough if unmolested. Bites, which are seldom fatal except in persons in poor health, are usually the result of inadvertant disturbance of the snake caused by not noticing its presence. Warm places where it can bask in the sun are the adder's favourite haunts.

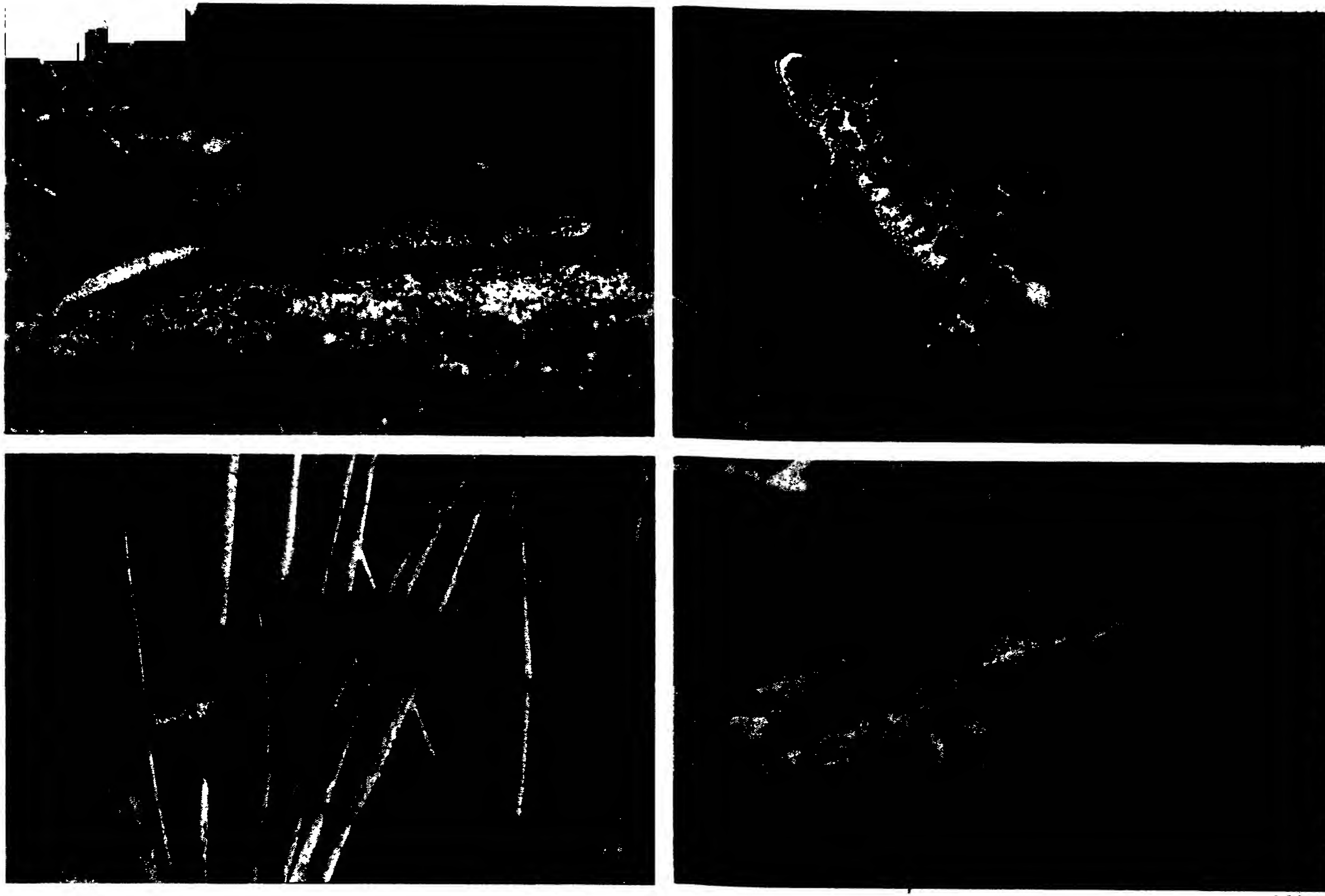




S. Crook

GRASS SNAKE AND THE SLOW-WORM THAT IS REALLY A LIZARD

To most people the slow-worm (top) looks like a snake and often this entirely harmless and quite useful lizard gets killed in case it might after all be poisonous. For the slow-worm is a lizard, not a snake or a worm. The limbs are rudimentary and do not appear outside the skin but the surest way of seeing that it really is a lizard is by noting the fact that it has eyelids, which no snakes have. The grass-snake (bottom) is the largest and most numerous of British snakes It grows to a length of from three to four feet and is very fond of the water.



S. Johnson

MALE AND FEMALE OF COMMON BRITISH AMPHIBIANS: SMOOTH AND CRESTED NEWTS

Of newts the most often seen is the smooth or common newt (lower photographs) which occurs all over Britain and also in Ireland. The back and sides may be either brown or green while the under parts are yellow and spotted with black. The ordinary length is about three and a half inches. In the male (bottom left) the under side of the flattened tail is in red with blue markings while in the female (bottom right) it is a plain yellow. The great water newt or crested newt is the largest British newt, the female (top right) being rather bigger than the male (top left). The back of this newt is dark brown or black, while the toes are yellow and ringed with black.

S. Crook

IN THE BREEDING SEASON: NEWTS AMONG THE RUSHES

All the British newts live on land except during the breeding season when they take to the water in which they were born. During this time the males develop a crest. The spawn is deposited among water-weeds in the spring or early summer and the tadpoles hatch out in about a month. The forelegs are the first to develop and the young newt at first breathes by means of gills which protrude from the neck. After about six months the gills have gradually dwindled away and the newt leaves the water for a life ashore.

The adder or viper (*Vipera berus*), the sole venomous reptile in Great Britain, occurs in greater or less frequency in every county. It is the only indigenous snake in Scotland, where it is very plentiful in some northern districts. Like the other snakes, it is absent from Ireland. In Wales it is very common in certain parts, rarer in others. It is common on the islands of Mull and Jura.

VERY exaggerated stories are often told regarding the size of adders. Hasty estimates of snake measurements are not to be relied upon, and it is easy to stretch the body of a snake an inch or two.

It is important to remember that the average size of adult adders is from 20 to 25 inches. Specimens of 26 inches are rare, and none have been authenticated of 30 inches despite the stories one hears. The largest ever measured by the writer, out of several hundreds, was 28½ inches. The female is rather larger than the male.

In appearance the adder is well defined and ought not to be mistaken for the harmless grass snake, though it bears a close resemblance to the very rare smooth snake. At the back of the head are two dark bands converging to form the characteristic V-shaped mark. These are always present, but in great variety of detailed shape. Immediately behind them is a lighter part, which shows them up. Then running along the middle of the back is the well-known zig-zag black or dark line, continued to the tip of the short tail. There is a row of dark patches along each side of the body.

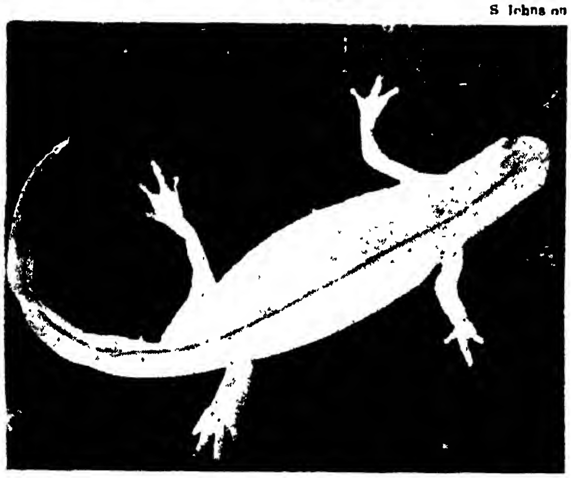
The lip scales, usually eight or nine, are yellow. The belly varies with age and sex from grey to slate-blue or darker. The sexes can be easily distinguished by the tail, which in the females is an obvious appendage, while in the male it is not sharply defined.

Adders like heat, and the warmest spot in the locality is their favourite haunt. As a rule, they avoid water but are capable swimmers if necessity arises. Their favourite food is the field mouse, but they also take lizards, especially slow-worms, eggs, small birds, and insects. The writer has also found the smooth newt, water voles, and young rats to form part of the food.

The poison apparatus consists of fangs, a gland to secrete venom, a duct from the gland to the fang, and special muscular arrangements to enable the adder to strike its victim. When about to strike, the

S Crook

S Johnson



John T. Roberts

PALMATED NEWT AND ITS SKIN

The palmated newt is the smallest of British newts and is only three inches long (top and centre). The lower photograph shows a complete skin found in the water after it had been shed by a growing newt. All newts are harmless to man, and carnivorous.

There is a small red viper, thought by some to be a separate variety. It measures from 12 to 15 inches in length, and is of a coppery red colour in both sexes. Its distribution is limited.

Male and female adders are often found pairing in April or May. Development takes about four months and the young adders are born alive usually early in September. The average number of the family, in the writer's experience, is thirteen. The fewest found was seven, the most twenty. They are from four to six or more inches long at birth, and at once show the vicious temperament of the species. All adders are untamable and refuse food in captivity.

There is a common belief in many places that the mother adder will swallow or take into her gullet the whole family in case of danger threatening them. It need only be said that this phenomenon has never been proved to the satisfaction of any naturalist.

The smooth snake (*Coronella austriaca*), though common abroad, is rare in Great Britain. It is probably restricted to Dorset, Hants, Surrey, and Berks, and is scarce even there. Adults are about two feet long, brownish in colour, having two series of irregular dark spots on the back. The favourite food consists of lizards and mice. It is quite harmless, but rather fierce in disposition. In general size and appearance the smooth snake somewhat resembles the adder, and has been killed in mistake for that reptile, but the characteristic adder markings are entirely absent.

All British lizards have one anatomical character which differentiates them from the snakes, namely, the two halves of the lower jaw are firmly united by a bony joint which does not allow of distension. Most have two pairs of limbs built on the typical vertebrate style, but some show no external limbs at all, giving them a snake-like appearance such as that seen in the British slow-worm. Most have movable eyelids, whilst snakes have none.

A curious property of some lizards is the readiness with which a portion of the tail breaks off, and the capacity for very imperfectly reproducing the lost portion. Like snakes, they cast their sloughs periodically, sometimes whole, more often in pieces. The majority reproduce their young from deposited eggs, while some carry the embryos till just on full time, when the eggs are laid. Still others bring forth the young alive.

Only three species of lizards are found on the mainland of Great Britain, but if we include the

Channel Islands as a British area, two others must be included. The mainland species are the common lizard, the sand lizard, and the slow-worm (or blind-worm); the extra two in the Channel Islands are the green lizard and the wall lizard. We may note some special features of each of these.

The common lizard (*Lacerta vivipara*), also known as the viviparous lizard and sometimes as the scale lizard, has a wide European distribution and is chiefly found in high lands and mountainous districts rather than in very low-lying parts. In this it differs from the sand lizard. We find the common lizard in England, Scotland, Ireland and Wales, unlike the slow-worm, which is altogether absent from Ireland.

The frequent statement that there are no reptiles in Ireland is, therefore, inaccurate; but there are no snakes. To account for the fact that the common lizard is the only Irish reptile, it is thought by some that this species preceded the other reptilian species in their spread from the continent, and arrived at a time when the mainland was continuous from the Continent to Ireland. Ireland then became cut off from Great Britain, but in the latter country the common lizard had been followed by the slow-worm and the sand lizard, as well as by three snakes, before the separation occurred.

The general colour of the common lizard is brownish above with small spots, often with a black streak along the back and a dark streak along the sides. The belly in the male is orange red with black spots, and paler in the female.

In England the common lizard is found in flat districts as well as hilly ones, especially, in my experience, in dry and sandy spots. Moors and commons and heaths, as well as sandy places near the sea, are equally favoured. Deep valleys and dark woods seem to be avoided.

Many reptiles are slow and sluggish, but the common lizard is a very active little creature, and very difficult to catch once it is in motion. This lizard has a greater objection to being handled than either the slow-worm or the sand lizard, but nevertheless it does become accustomed to it in captivity, as may be seen in the illustration in page 476 of two (male and female) basking in the writer's hand. These were captured on a sunny bank on the coast of the Isle of Man.

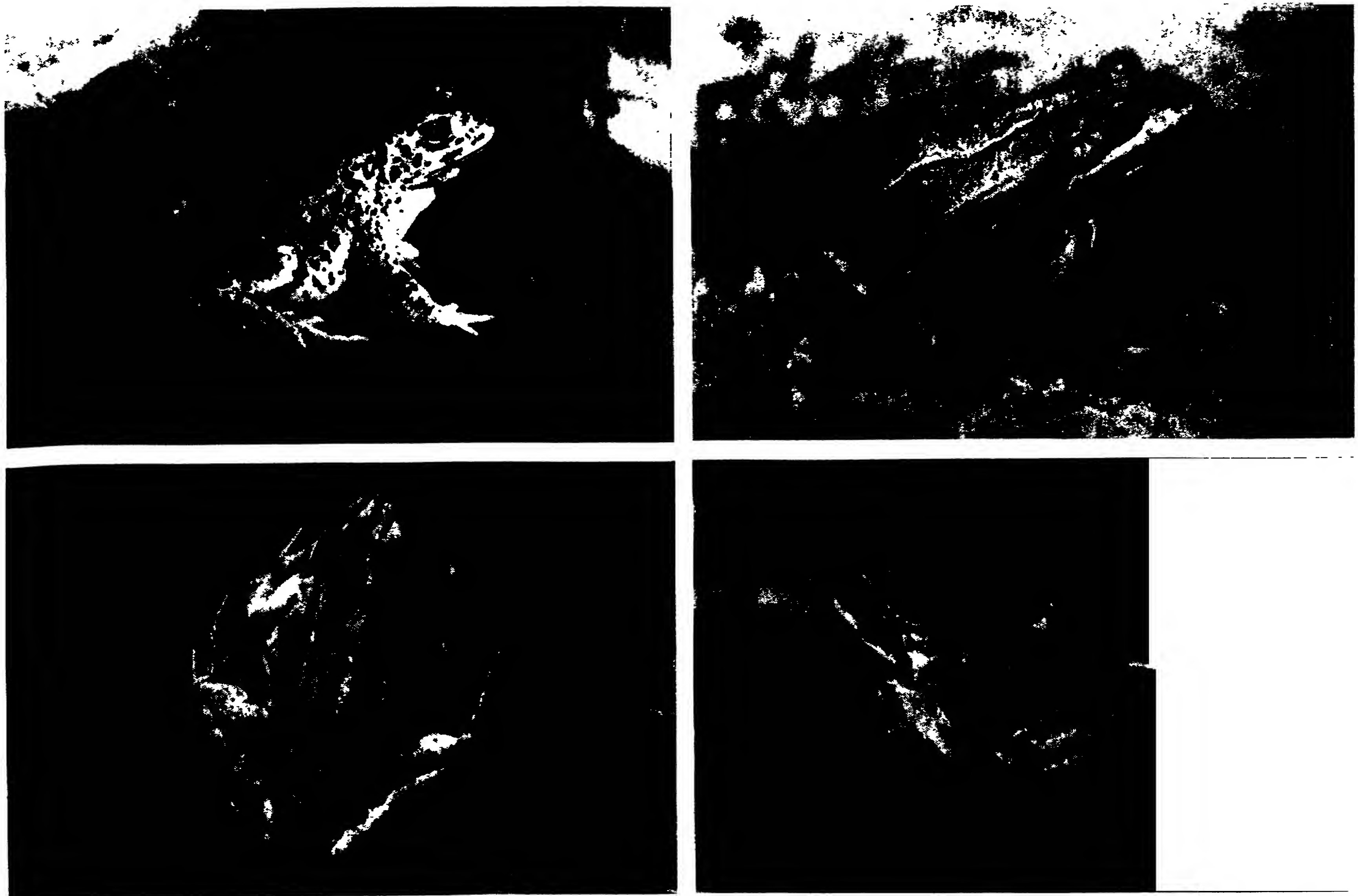
Insects constitute the main food supply. Flies of various kinds, as well as ground insects, are taken. Worms, too, are welcomed.

The scientific name of the common lizard indicates that the young are born alive or carried to full time. The family varies in number from six to twelve, and is born from July onwards, according to the earliness of the local summer. No nest of any kind is made; the young burst the egg membrane and are left to their own devices. They are perfectly developed at birth and quite able to look for insects and otherwise to fend for themselves without assistance being rendered by their parents.

M. H. Crawford

HOW THE TOAD HIDES

Here is a toad which was found in front of a stone (bottom). Upon alarm it retreated backwards (centre) in typical toad fashion, throwing up the soil in front of it as it went, until finally it had made good its retreat (top) under the stone's protection.



S. Johnson

COMMON AND EDIBLE FROG AND THE RARELY SEEN NATTERJACK TOAD

The common frog (bottom photographs) is found almost everywhere in Great Britain and it lives largely upon insects which it catches with its specialised tongue. The usual length is about three inches and the hind legs are more than half as long again. The colouring is brown and the skin is often spotted. Most of its life the frog spends on land. The edible frog (top right) is usually larger in size and is found chiefly in the eastern counties. It may be distinguished by the fold in the skin on either side of the back. On the Continent this species is highly thought of as a dish the thighs resembling young chicken. The natterjack (top left) is rather rare and less clumsy-looking than the common toad. The general colour is green.

The sand lizard (*Lacerta agilis*) is a dweller of the plains rather than the mountains, and is widely distributed in Europe but sparsely in Great Britain, where it is practically restricted to Dorset, Hants, Surrey and the neighbourhood of Southport. It is sometimes reported in error for the common lizard.

It is larger than the common lizard, the females reaching eight inches long, or a little more. The colour varies much. Brown predominates in the females and green in the males. Rows of dark and light spots occur in both sexes. The male tail is longer than that of the female. As its name implies, sandy districts are its favourite haunts. The warmth of the sand assists reproduction, for the eggs are simply deposited in sand and left to hatch out. Insects of various kinds are the staple diet. This species is the only one of the three British mainland lizards which is an egg-layer, like the green lizard and the wall lizard of the Channel Islands.

The fact that the slow-worm or blind-worm (*Anguis fragilis*) has no external limbs is quite enough for most people to regard it as a poisonous snake and destroy it at sight. Not only is it perfectly harmless, but actually a very useful creature, because its favourite diet is the slug. It is, of course, neither blind nor a worm. Its bright little eyes have eyelids, which snakes have not. It often lies motionless, but its individual movements are not slow. It is the fact that it has only rudimentary limbs under the skin which cause the ignorant to persecute it as a snake. It is, indeed, an intermediate form between lizards and snakes, one of the many connecting links between separate groups found in nature, indicating the evolution from generalised to specialised types.

The slow-worm is common in most parts of Great Britain, but absent from Ireland. A full-grown adult measures from 12 to 15 inches long. In females about half the length consists of tail. The skin is remarkably smooth, but quite dry. The tongue is notched. The tail is easily fractured, and this often enables the slow-worm to escape with its life from a snake or other enemy which has seized it.

There is great variation in colour. The young are silvery white above, with black bellies. Adults have grey, brownish or even coppery bodies, and grey bellies. Their food is mainly slugs, the common garden slug for preference, of which a dozen may be eaten in a very short time. The young are carried to full time, bursting the egg membrane in August or September to the number of four, six, or as many as twelve. They are from two to three and a half inches long at birth, and active at once.

The slough is cast periodically and hibernation begins rather later than in most of the reptiles.

The green lizard (*Lacerta viridis*) is not indigenous to England, Scotland, or Ireland, but is common in the centre and south of Europe. It is much larger than our other species, the adult reaching 12 to 15 inches long. The tail accounts for most of this, almost three-quarters in long males. The predominating colour is green, especially above. The back is often mottled with spots; the male throat is bluish in the breeding season. There is a semi-circular collar on the neck, the head is flat, the eyes prominent, and the snout rather pointed.

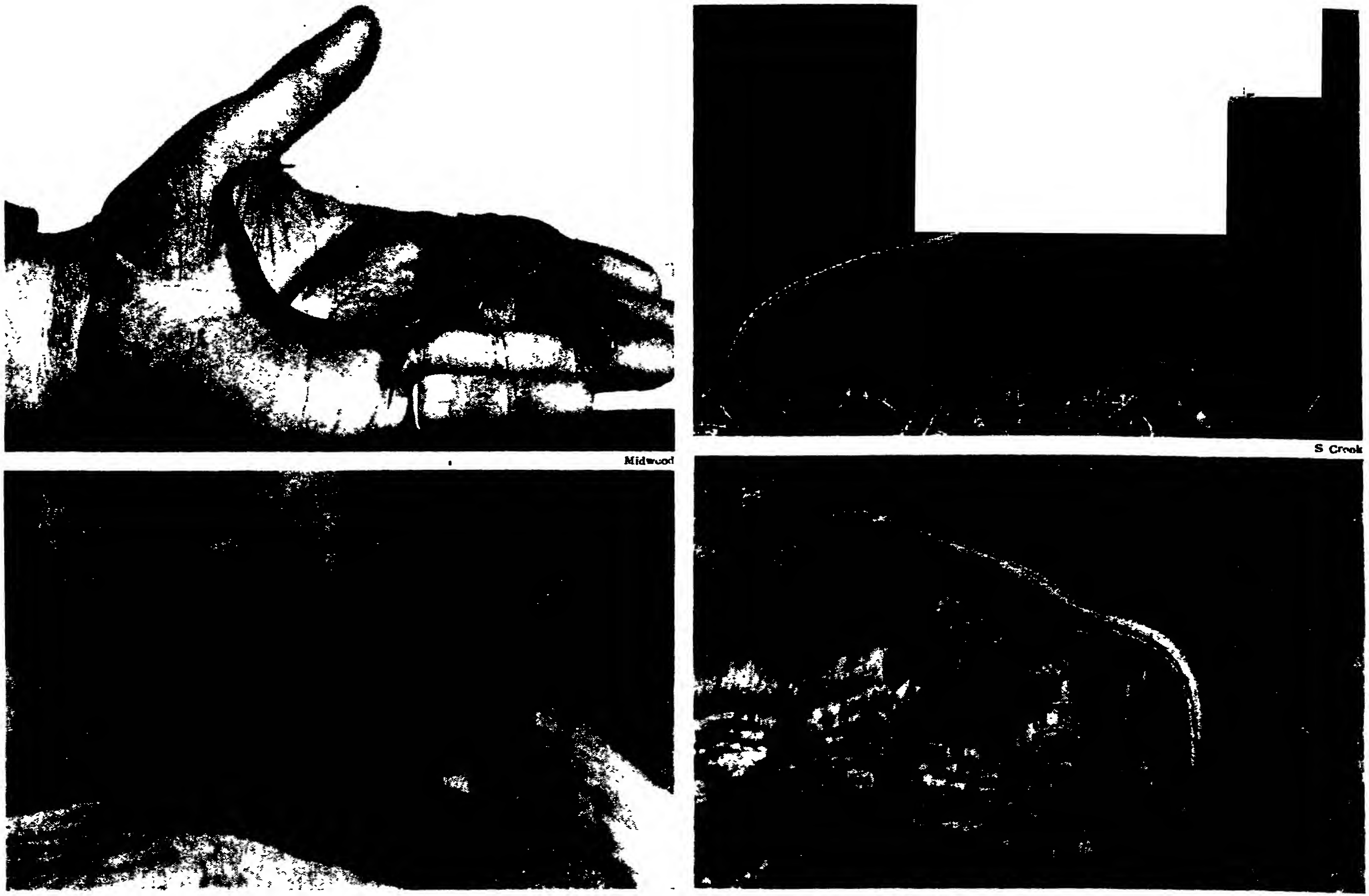
It prefers rocky ground in the Channel Islands. Insects, worms, and snails are eaten. The writer once found a specimen of the sand lizard in the gullet of a smooth snake, the lizard's stomach being full of beetles, the three creatures forming a striking object-lesson in the struggle for natural existence. The females carry the fertilised eggs for a time, and then deposit them in a suitable warm spot, the whole period of gestation being eight weeks. The eggs are usually eight to ten in number.

The wall lizard (*Lacerta muralis*), the other Channel Island lizard, is very common in South Europe as well as Northern Africa and Asia Minor. It is a small lizard from six to eight inches long, exhibiting great colour variation. Usually it is brown or greyish above, with white, yellow or pink belly, sometimes spotted. It gets its name from its habit of basking on walls. It is oviparous.

All the amphibians with which we have to deal have the following characters in common: they are cold-blooded vertebrates of a creeping habit. Thei skin is smooth and clammy and has no scales. Ther is a remarkable difference between the young and the adults, because the young live in water, in which they breathe by gills. In adult life they become as a rule land animals, breathing by lungs. The blood corpuscles are nucleated, oval and biconvex in shape. The limbs never take on the fin characters of fish. The fingers and toes have no claws.

In general appearance the tailed amphibians such as newts are not unlike some lizards, but the newts are very much slower in their movements. They are perfectly harmless creatures, in spite of various superstitions which attach to some of them. These are associated with the irritating properties of the skin, which has poison glands of a very mild character. This secretion is very distasteful to other mammals, and is the best defence of the amphibian. It feeds chiefly on insects, of which it consumes large numbers, capturing them by means of its sticky tongue. Frogs and toads are the most common amphibians, and are found practically all over the world.

The common frog (*Rana temporaria*) is about three inches long. Teeth are present in the upper jaw and on the palate. The insect-catching tongue is notched. The fingers are free, but the toes are webbed for swimming. The hind legs seem very long in proportion to the rest of the creature, being more than half as long again as the body. In colour the frog is of varying shades of brown, with or without dark spots. Often the males are yellowish-white below, and the females a darker orange colour. The female is larger than the male. The colour changes to a certain extent with the surroundings. There is a nictitating membrane in connexion with the eye. The general habit is terrestrial rather than aquatic



Midwood

S Crook

S. Johnson

GREEN LIZARD OF THE CHANNEL ISLANDS AND THE SAND AND COMMON LIZARDS

Great Britain has only three species of lizard but there are two other kinds found in the Channel Islands. Of these the green lizard (bottom left) is much larger than the others, growing more than a foot long. It is found in rocky ground and feeds upon insects, snails and worms. The sand lizard (bottom right) is sparsely distributed in the south of England and very rare elsewhere. Dorset and Hampshire are the places in which to find it most easily. The females are brown and the males green, and both sexes are spotted. The eggs are laid in the sand which the lizard frequents and allowed to hatch in the sun's heat. The upper photographs are of the common lizard. The two in the upper left photograph were captured in the Isle of Man.

In the breeding season the male develops a swelling on the fore-foot. The spawn is deposited in early spring in ponds, where it may be seen floating about in irregular masses. In about three weeks the fertilised eggs produce tadpoles, which at this stage are not in the least like frogs. Their metamorphosis is a fascinating study. At first they breathe by gills in a fold of the skin. They show a beak-like mouth, and possess a long tail. This tail gradually becomes absorbed and the mouth loses its beaky appearance. Then the limbs begin to develop, the gills disappear in favour of lungs, and the tadpole becomes a perfect frog.

THE common toad (*Bufo vulgaris*) has a reputation which is not deserved. It is doubtless an unpopular creature, credited with a habit of spitting of which it is not guilty. It is not poisonous, but it has, as a means of defence, a dirty, whitish secretion in the pores of the skin which has an irritant effect. When excited the toad puffs itself out and exudes beads of this secretion.

It is a clumsily-built creature, three and a half inches long as a rule, but growing to larger dimensions. The large, flat head with gaping mouth, brown colour, and warty skin are familiar characters. There are swellings over the eyes like warts. The legs are shorter than the frog's legs, the hind ones being a little longer than the body. There are no teeth. The tongue is attached in front in the mouth, but is free behind; it is slightly cleft at the tip, and is an insect-catching apparatus of great perfection. The male toad is smaller than the female.

The toad is a terrestrial liver commonly found among stones in damp places. The slough is cast several times a year, and often swallowed. In addition to insects, toads feed largely on worms. Stories of toads having lived for years in stones, *without any air*, should be received with caution.

The natterjack toad (*Bufo calamita*) is much rarer than the common toad, and is absent altogether from the Scottish Highlands. It may be distinguished by means of a light-coloured line along the centre of the back, which has given it the name of Golden Back. In size the natterjack is about two and three-quarter inches long. It has a less clumsy appearance than the common toad, but the eyes project more and the eyelids are more elevated. The hind legs, in this case, are not so long as the body. Both sexes are of the same size. The general colour is greenish with spots, the under parts whitish, and often speckled with black. In habit this species is more active than the common toad. It feeds on insects.

All British newts are terrestrial in their habits, except in the breeding season. They spawn on or in the crumpled leaves of various water plants. They differ from the frogs and toads in that they retain the tail throughout their lives, as well as in the fact that they put on a special appearance in the breeding season. All newts are carnivorous. All are quite harmless, though somewhat unpopular.

The smooth or common newt (*Molge vulgaris*) is the most common of all newts in Great Britain, and

TOADS ON THE HUNT FOR FOOD

In spite of their slow rate of progress and awkward movements toads are by no means so sedentary and sluggish as is often supposed. Their gait, if unhurried, is very determined, and the photograph shows two of them off upon a voyage of exploration.

is found in Ireland. It is about three and a half inches in length, green or brown in colour, profusely spotted. Below it is yellow with black spots. The chin is also yellow. In the male the lower surface of the flat tail is reddish, with bluish lines and markings. In the female it is yellow, without markings.

In the breeding season the male puts on a festooned frill along the crest of the back, and the female a smaller frill. The eggs are laid in strings of four or six. The tadpoles are dotted with yellow. Water is only sought in the warm months when the slough is cast.

The palmated newt (*Molge palmata*) is the smallest of our newts, being only three inches long. The chin is colourless. The male toes are webbed, and in the breeding season a filament appears on the tail.

THE great water newt or crested newt (*Molge cristata*) is our largest newt, measuring five and a half inches in length. It is black or dark brown above and yellow underneath spotted with black. The female is slightly the larger. The toes are yellow, and are decorated with black rings.

In the breeding season the male is distinguished by a high, serrated crest along the back and a further crest along the tail. The eggs are laid in the water usually in May or June, and deposited in the folds of water plants or grasses. In from three weeks to a month the tadpoles hatch out, yellowish-green in colour with black stripes. The fore-legs appear first, the hind-legs follow some weeks later. In about six months, the gills having disappeared, the young newt leaves the water for a land existence and does not return for three years, when the male reaches maturity. After that a water life is lived annually for some three months during the breeding season.

The tadpoles of all newts are herbivorous, but in the adult life all the newts are carnivorous creatures. They feed largely on the tadpoles of frogs.

The crested newt is said to hibernate in companies of different ages, those over three years separating from the younger ones.

E.N.A

STAG AND ZEBRA OBEY THE LAW OF THE HERD

With animals that live together for mutual protection in herds, like deer (top) and the zebras (bottom), there are certain instinctive laws which are always obeyed. Any attempt at individuality or eccentricity in this matter is punished by ostracism or active persecution. These laws of the herd require that the females and the young shall be protected by the herd as a whole and the males in particular. Fighting is discouraged save for purposes of deciding leadership and at mating time, when the survival of the fittest obeys an obviously eugenic law.

Chapter XLVI

Law in the Animal World

By R. C. Macfie

I spoke as I saw.
I report as a man may of God's work—all's Love yet all's Law.

BROWNING

WE are inclined to think of law, at least of law applicable to conduct, as essentially and exclusively a human institution, and we are apt to imagine that wild animals, outside the orbit and influence of man's will, are lawless anarchists. But all living creatures are products of chemical and physical laws: the chemical substances of which they are built have obeyed the laws of chemical affinity, and not only the voluntary actions of man but the physiological processes and instinctive actions of the lower animals obey certain rules of life. A world without law would be a chaotic world inhabited by lunatics. The reign of law in Nature is universal—not only law physical and chemical, but law affecting conduct; and though man and possibly other animals may guide and use law, they cannot escape from it, nor abolish it.

The term "law" is, of course, commonly used in several senses; it is used to denote a certain regularity of happenings—a certain invariable sequence of events. A stone thrown up in the air always falls down again, and it always falls at a steadily accelerating rate which can be noted in a mathematical formula. A man eating a sapid substance always secretes a certain substance called saliva, and it is always secreted according to certain known physiological and chemical laws; it has always certain composition, and is always produced by certain cells, in certain quantities, under certain definite conditions. Such invariable linked events are instances of what is called law. But the term "law" may be applied also to the something—to the power behind the events—that links them together.

God is law say the wise, but if He thunder by rule
The thunder is yet His voice.

In whichever of these senses we use the word law it still stands true that law is universal in animal conduct. In man there may be a force called "will" and in animals a force called "instinct" producing invariable sequences of conduct, but invariable sequences of conduct there always are and variation in these sequences—through a lapse of will, or through a lapse of instinct—are abnormal, and mean in the long run death. Rules of conduct, patterns of conduct, whether voluntary or instinctive are the *sine qua non* of life, even though we cannot see their vital value.

Even in such lowly organisms as the amoebas and the bacteria, we find that behaviour is according to law, that movements are not erratic and capricious, but always of such a character as to bring about certain general results, some of which at least are conducive to the welfare of the organism. We find, too, that the relation between stimulus and response varies, as in the case of man, in accordance with Weber's law. However lowly and minute the organism it is ruled by laws in obedience to which its welfare and indeed its very existence depend.

It is so, too, all along the animal scale. Among earth's most ancient animals are the insects and arachnids. Long before the vertebrates appeared, millions of years before the coming of man, they crawled over Silurian ferns, or flitted through Carboniferous thickets, or worried Jurassic dinosaurs, or were hunted by Jurassic pterodactyls. But even these early little creatures were communists, not anarchists, and to-day we find among them rules of conduct observed with a mathematical punctiliousness—rules of conduct which, whether consciously or unconsciously observed, were yet necessary for their survival. They are amongst the smallest of Earth's inhabitants; some are so small as to be invisible, and yet they have succeeded so well in the struggle to survive that taken to-day there are more than two million species which altogether outnumber and outweigh all the vertebrates. Only by following advantageous rules of life could they have thriven and multiplied in such an amazing way.

TAKE the spider, whose ancestors can be traced back to Palaeozoic times. We find that its conduct, though individualistic and bloodthirsty, is far from anarchic, that, indeed, it conforms persistently to certain detailed rules of life. Look with what mathematical accuracy, with what careful skill, with what ingenuity, with what patience, the ordinary garden spider spins its web! It might no doubt form a web good enough to catch flies by simply making a wild tangle of threads; but it proceeds like an artist and engineer; its web is made according to law, and is itself an exemplification of law and of the value of obeying law. Beginning by laying down a number of circumferential threads to mark out the area of the web, the spider next lays the radial threads which intersect in the centre. "Finally beginning at the circumference and working inwards the spider lays down the delicate viscid spirals on which the efficiency of the web depends. The primary spirals simply form a scaffolding, and are undone, in fact eaten up, as soon as they are displaced." The work is methodical according to plan, according to law: it is a precise adaptation of means to an end.

Or take the wax hive of the ordinary bee. It is built not anyhow, but in accordance with law, and by the combined and co-operative efforts of swarms of architects. Each bee does its own little lawful bit of work and no more, and all the bees follow the principles or laws of solid geometry. Together they make the cells regular hexagons because the hexagon

is the most convenient and the strongest shape ; also they make the bottom of the cells of three planes meeting at an angle which mathematicians have proved to be the very angle to economise both material and labour.

FURTHER, in the hive there is regular distribution of labour, as if by decree. There are workers, each with its proper task ; there are nurses who look after the nymphs and the larvae ; there are ladies in waiting who attend on the queen, there are " punkah " bees who ventilate the hive and evaporate water from the honey by fanning with their wings, there are architects who make the honeycomb, there are foragers who collect the honey and pollen, and salt, and water, there are the chemists who preserve the honey with formic acid, there are the sweepers who keep the hive and its approaches clean ; there are the amazons who guard the hive and drive away all foes ; there is the queen whose one duty it is to propagate the species. All these work in accordance with law as faithfully and definitely as the wheels of a watch. They obey law, and they obey it even when it makes demands that mean loss and unhappiness to the individual. Every year there comes the day of the great annual sacrifice—the sacrifice so brilliantly described by Maeterlinck, when the bees swarm and " the thrice happy city is scattered abroad in obedience to a law superior to its own happiness." He says :

> Never is the hive more beautiful than on the eve of its heroic renouncement. From the height of a dome more colossal than that of St. Peter's at Rome, waxen walls descend to the ground, balanced in the void and the darkness ; gigantic and manifold, vertical and parallel geometric constructions, to which, for relative precision, audacity, and vastness no human structure is comparable. Each of these walls, whose substance still is immaculate and fragrant, of virginal silvery freshness, contains thousands of cells stored with provisions sufficient to feed the whole people for several weeks. Here lodged in transparent cells, are the pollens, love-ferment of every flower of spring, making brilliant splashes of red and yellow, of black and mauve. Close by, sealed with a seal to be broken only in days of supreme distress, the honey of April is stored, most limpid and perfumed of all, in twenty thousand reservoirs that form a long and magnificent embroidery of gold whose borders hang stiff and rigid Still lower the honey of May matures, in great open vats by whose side watchful cohorts maintain an incessant current of air

IN the centre " is the royal domain of the brood-cells, set apart for the queen and her acolytes ; about 10,000 cells wherein the eggs repose, 15,000 or 16,000 chambers tenanted by larvae, 40,000 dwellings inhabited by white nymphs to whom thousands of nurses minister. And finally in the holy of holies of these parts, are the three, four, six or twelve sealed palaces, vast in size compared with the others, where the adolescent princesses lie who await their hour, wrapped in a kind of shroud all of them motionless and pale and fed in the darkness."

Out of this palace of beauty and luxury the bees are driven by the flaming sword of the law of sacrifice, against whose decree of banishment and exile there is no redress and no appeal, surrendering not only their palace but a store of honey representing twelve times the entire weight of the bee population. There could be no more dramatic illustration of the Law of Sacrifice that underlies life. Yet the massacre of the males that follows on the nuptial flight and impregnation of a virgin queen bee is, perhaps, an instance of sacrificial law even more striking. As is well known the chosen bee who consummates wedlock with the virgin queen dies in the act : it is law, there is no way out of it. But not only the chosen lover dies, but in time all his comrades. For one day the law of sacrifice ordains the death of all the males, and the " stern workers who recognize only Nature's harsh and profound laws " promptly massacre them without mercy.

These are instances of law operating *en masse* in mighty matters, but even in small matters there are codes that must be respected. A queen may never use her curved sting against any bee save only a rival queen ; and no bee save a queen bee dare sting a queen. " For it is written that against a mother the sting may be drawn by a mother alone ; only she who bears in her flanks close on two million lives appears to possess the right with one blow to inflict close on two million deaths." When a queen is to be killed by her subjects she must be suffocated in a " scrum," or held till she dies of starvation.

THE termites and the ants, like the bees, are social insects, are equally under law, and equally live their lives according to law.

The economic laws of some species of the termites are even more elaborate than those of the bees, and even more pervaded with the idea of self-sacrifice. Maeterlinck says " we find in the termite a wholehearted, heroic, deliberative and intelligent sacrifice to an idea or an instinct—a sacrifice that is without limit and almost infinite. It brings the victims nearer to ourselves and makes them also our brothers, and from certain points of view causes these wretched insects, more than the bee or any other living creature on earth, to become the heralds, perhaps the precursors, of our own destiny."

It is a vulnerable, defenceless insect and only by means of organized law has it succeeded in surviving and making for itself a kind of insect society and civilization. There are four main classes of termites—workers, warriors, and males and royalties ; and the males are starved to death after the nuptial flight is accomplished.

The wonderful social organization of the ants, too, depends on a faithful obedience to salutary laws and the same dependance can be illustrated from the lives of beetles and many other insects. What is behind the economic laws which these little organisms obey is a mystery, but the fact remains that they do obey laws and that on their obedience their very existence depends.

We have specially insisted on law in the insect world because insects are especially social animals, and law in the truest sense of the word means certain general rules of conduct implicitly followed by the members of a community for the common weal.

MUTUAL TOLERATION OVER THE VITAL MATTERS OF FEEDING AND DRINKING

Despite their extreme ferocity which, it might be thought, would cause endless strife, the lionesses, which live all together in one cage at the Paris Zoological Gardens (bottom), have learned to behave themselves even over the vexed question of food. Each one settles down to its own share in obedience to the only rule which could make life tolerable behind those relentless iron bars. Above we see some wild animals in the Kruger National Park, Africa. They consist of zebra and wildebeest and are sharing a waterhole.

But there is, of course, equally a reign of law in the case of the larger animals.

Take, for instance, the migration of birds. The migratory birds all migrate by law, at a fixed time, in a fixed direction—"The stork in the heaven knoweth her appointed times; and the turtle and the crane and the swallow observe the time of their coming." So regular are the dates of migration, that in India some of the months used to be named after migrants. So unanimous is the response to the inner call of the unwritten law that the flocks of birds move *en masse* like army battalions. So imperious is the law that some birds cover in their migration a distance of thousands of miles. The stork flies between Germany and Natal. The curlew and sandpiper fly from the far north to New Zealand. The dotterel passes to and fro between the North African steppes and the Arctic tundra. The Virginian plover and the warbler journey between Labrador and North Brazil. The Arctic tern beats them all by alternating between Maine and the Antarctic zone.

But even in the egg the bird acts by rule and not by caprice. The chick, in order to break the egg-shell, always chips round in a circle moving from left to right. It works quite uniformly and regularly and consistently.

In the nest, too, law and order is always preserved. For a week or two, perhaps for seven weeks, the mother bird will sit patiently on the eggs while the father bird forages for food and protects the nest. Often the mother has an hour or two of off-time, and the father takes her place.

SIMILAR law and order is exhibited by birds in many situations of life. The pelicans, says Kropotkin, "always go fishing in numerous bands and having chosen an appropriate bay, they form a wide half-circle in face of the shore and narrow it by paddling towards the shore and catching all fish that happen to be enclosed in the circle. On narrow rivers and canals they even divide into two parties, each of which draws up in a half-cricle and both paddle to meet each other, just as if two parties of men, dragging two long nets should advance to capture all fish taken between the nets when both parties come to meet. As the night comes they fly to their resting-place—always the same for each flock—and no one has ever seen them fighting for the possession either of bay or resting-place. In South America, they gather in flocks of from forty to fifty thousand individuals; some enjoy sleep while others keep watch; and others again go fishing."

That is social law practised for the good of the community. In the case of all animals that live in flocks, and packs, and herds, there have to be social rules and laws, though they are not so marked as in the case of the communal insects. Children and mothers are looked after and protected: there is no fighting permitted between members of the clan except at mating-time, or to establish leadership. In many cases there is a sentinel set to keep guard when a flock or herd is liable to be attacked by an enemy, and movement is usually *en masse*. Offenders against the unwritten law are punished, and eccentrics are liable to be ostracised.

Even in the jungle there is jungle-law. "The law of the jungle," says Kipling in "The Jungle Book"—"which is by far the oldest law in the world—has arranged for almost any kind of accident that may befall the Jungle People till now its code is almost perfect."

What exactly the jungle-laws are, not even Kipling knows, but he is probably right when he declares that in time of drought a "water-truce" is declared, and tiger, bear, deer, buffalo, and pig all drink together.

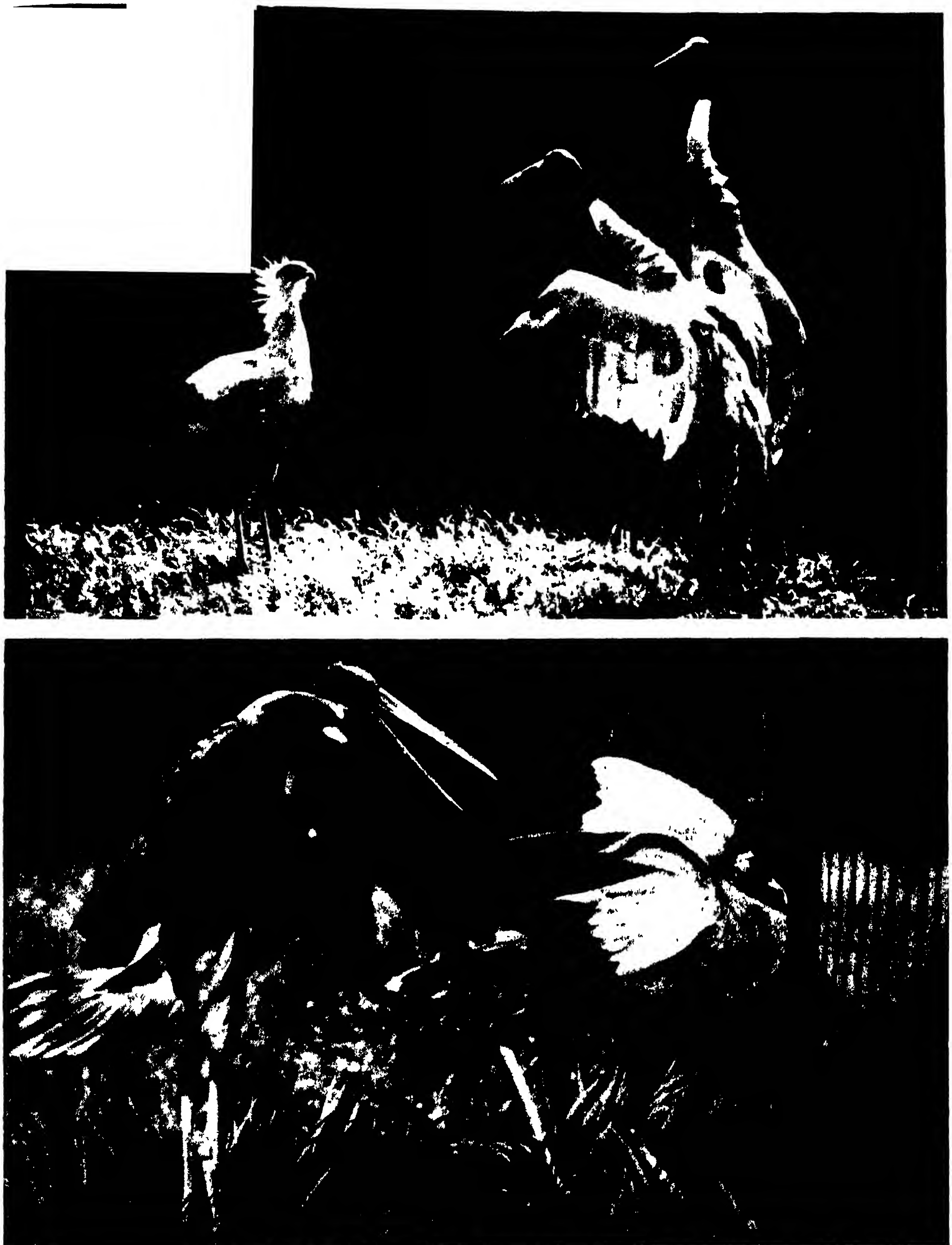
> The pools are shrunk, the streams are dry
> And we are playmates, thou and I,
> Till yonder cloud—Good Hunting—loose
> The rain that breaks our water-truce.

THE laws of animals are, of course, based not on reason, but on instinct, and they all make on the whole for the health and preservation of the individual or of the race. It is obedience to these unwritten laws that enables any group of animals to survive, and disobedience and lawlessness mean death. But the laws are meant to deal only with average and normal situations: they fail when novel emergencies arise, and obedience in such circumstances to the laws of the instinct may and often does mean disaster. The lemmings driven on by an instinctive urge are drowned: the moths perish in the candle-flame.

Man is one of the animals, and he, too, is under the laws of certain animal instincts. The instincts to eat, to propagate his kind, to kill his enemy, to hunt, to play, have the force of laws with him, and if they weaken or if he fails to obey them, the race of man will perish. But man has discovered that these instinctive laws are not sufficient to guide his life in *all* cases, and that there are cases—as in the lower animals—when obedience to them must be ruinous or fatal, and so he has supplemented Nature's laws, with other laws meant to meet the special conditions of a complex civilization, and man to-day has to obey not only the laws of his nature, but the laws of God and the laws of the land. He cannot always, he need not always reason out a course of action, he has these extra general laws to guide him, and they are the laws that have made civilization and that have lifted him above the level of the other animals.

MAN from the first has been a creature of law especially requiring laws because of his communal character, and any endeavour now to emancipate himself from law, and live at his own sweet will, as an uncompromising individualist or anarchist, must be fatal both to the individual and the race.

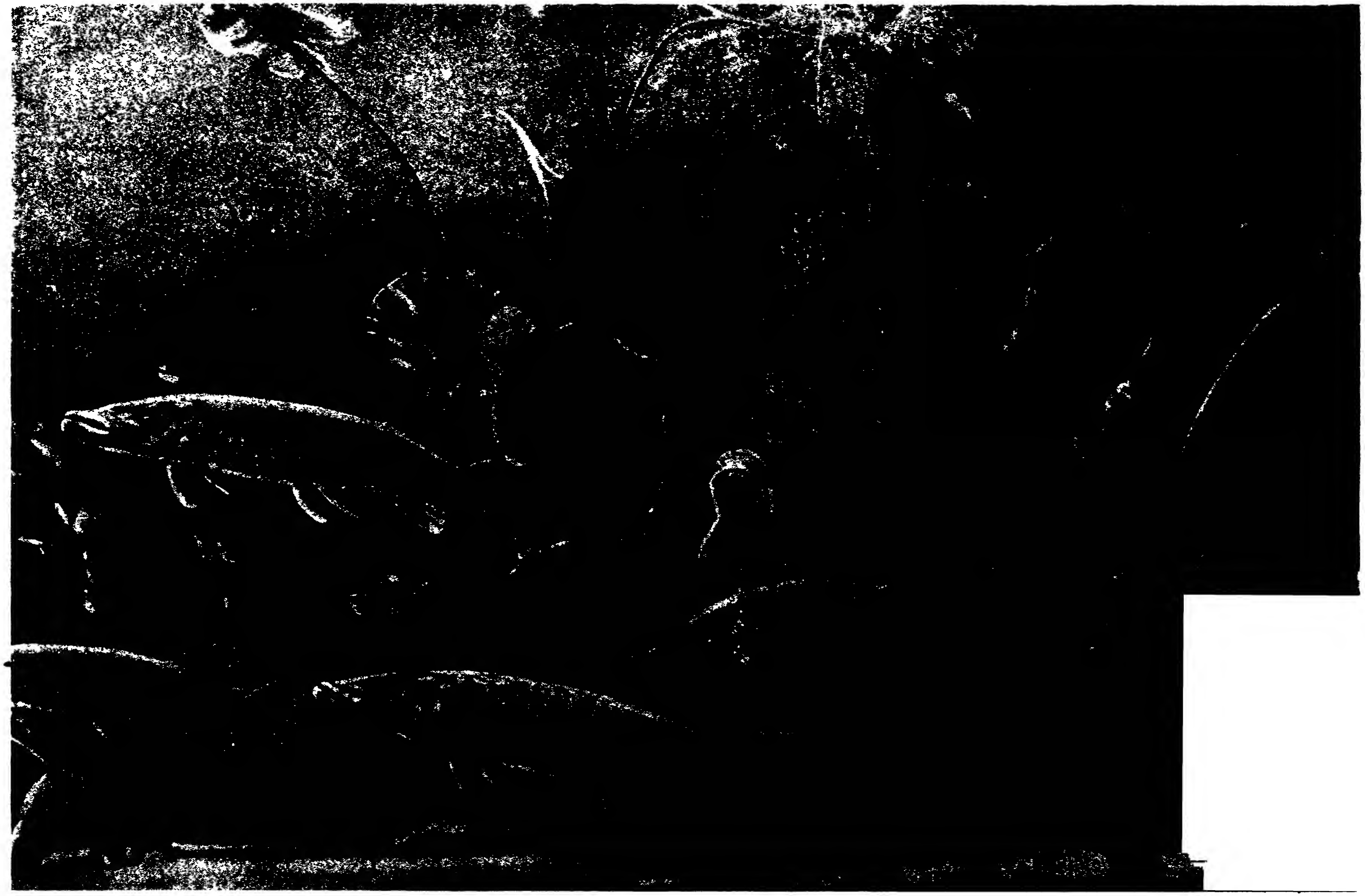
Yet each man is an individual: the human community is more than an ant-hill or a bee-hive; and, subject always to the safety of the community, each man should be as little law-bound as possible, and should be given liberty to go his own way and live his own life and develop his own individuality.



Neville Kingston

ADVENTURES OF A SECRETARY BIRD THAT BROKE THE RULE OF "BIRDS OF A FEATHER"

One day at the London Zoo the secretary bird, that lives among a number of other species, safely separated by bars, getting out of its pen. Next door were a couple of cranes (top) which immediately showed by their behaviour that the visit was not merely unwelcome but intolerable. The secretary bird got itself away from those dangerous beaks by flying out of the frying-pan into the fire of the next cage, where a stork lived (bottom). Luckily help arrived just in time to restore the unpopular visitor to its rightful place.



Neville Kingston

PIKE AND EELS, EVERY MOVEMENT OF WHOSE GILLS IS SEPARATING OXYGEN FROM THE WATER

Nature constructed one of her greatest marvels when she invented the gill. On examining the gills of a pike—a very unsafe operation until the fish is dead, since the mouth is furnished with a surprising quantity of teeth—a number of scarlet leaves are seen when the gill cover is pulled back. These leaves contain capillary blood vessels and are arranged so that the greatest possible number of these can be presented to the water, so that the oxygen may pass into the blood stream. There is a clear passage from the open mouth to the open gill cover save for these red breathing surfaces. The pike and eels seen above were photographed in the Aquarium at the London Zoo.

Chapter XLVII

The Fight for Oxygen

By Joseph Barcroft, C.B.E., F.R.S.

Professor of Physiology, Cambridge University: Author of "The Respiratory Function of the Blood"

The flame of life. Why the *flame* of life? The comparison of life to a flame is no mere rhetorical conceit; there lies underneath it some measure of material truth. The flame can only be supported as the result of incessant chemical activity and the same is true of life. But that is not all. The type of chemical activity in each case is similar: it is the oxidation of organic material. The chemistry of this flame is simple and intense, the chemistry of life is complicated and subdued; the flame burns, the body only smoulders, the flame is hot, the body is only warm; but whether in the flame or in every living cell, material is continually being consumed, it is continually giving out heat, it is continually undergoing the process known to chemists as oxidation, and for this reason it is clear that it must be fed with a sufficient and continual supply of oxygen.

This dependence upon oxygen is true of the humblest as well as the most highly organized forms of life. Whence comes this oxygen? For the furnace it comes from the draught of air without which the fires would go out; life depends upon the atmosphere as well. So far as *animal* life, at all events, is concerned there is no other source of supply. Fortunately there is no chance of this oxygen supply petering out. There are over five million tons of oxygen in the atmosphere over each square mile, and as no one in his lifetime uses more than about a ton, and most people very much less, there need be no apprehension about the supply.

The question is not is there enough oxygen in the universe, but by what means is it to be acquired? The most lowly forms of animal life are to be found in water, and indeed life itself is supposed to have had its beginnings not on land but in the ocean. The earliest forms of life were then divorced from the atmosphere; how were they to obtain oxygen? How were they to obtain *enough* oxygen?

As regards the path by which oxygen reaches them, fortunately that gas is to some extent soluble in water. Each time a wave breaks, some of the air in the foam becomes dissolved in the water, unless indeed this water is charged to the full extent possible under the circumstances. As the water all becomes mixed up and as in any case the dissolved gas can pass about through the water, it has no difficulty in reaching any living organism which is not situated at too great a depth.

But how to get enough? Fortunately the needs of these mean creatures are very limited. They themselves are extremely small, perhaps no bigger than the head of a pin, perhaps much smaller, so that the amount needed by any one cell—any unicellular organism—is rather trifling. Being so minute, every part of the cell is very near to the water in which the oxygen is dissolved, so the oxygen just soaks into the cell from the water outside much as the coffee in our cup soaks into the lump of sugar we put into it.

But the oxygen requirements of unicellular organisms are small not only because of the diminutive size of the creatures themselves. Even for its size such a thing as the amoeba demands but little oxygen and for at least two reasons: firstly because it is cold and secondly because it is inert. Of these considerations more will be heard later; here it is merely to be noted that size for size the warmer the temperature of an animal the more oxygen it requires, and also that its demand for oxygen increases rapidly in proportion to its activity.

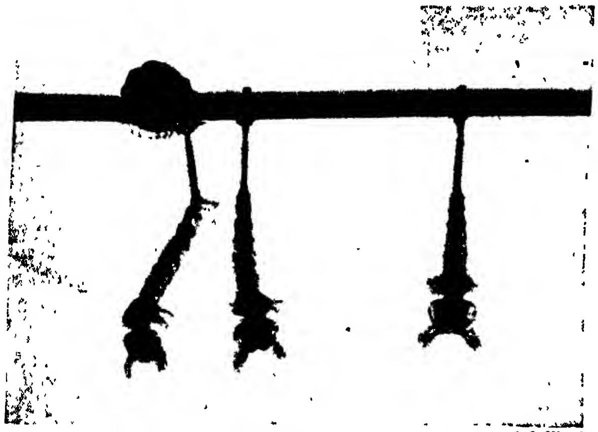
J. J. Ward

BREATHING TUBES AT WORK

The water scorpion has two respiratory tubes, so that if one gets blocked it can still breathe. These are attached to the tail end and are pushed through the surface film to the air

For the moment, however, let us keep to the cold and humble animals which live in water. As they developed and became more complicated it almost goes without saying that they became larger. The sea-urchin, for instance, does not rank very high in the scale of creation. Yet the sea-urchin has attained to quite a considerable size even in this country, whilst abroad there may be found sea-urchins of sorts about as large as the head of an average baby.

Oxygen never could soak into these creatures from the water in which they live in the same sort of way as the coffee soaks into the sugar. The process of soaking (or diffusion, to give it its proper name) is too slow



J. J. Ward

GNAT LARVAE AT THE SURFACE

It was the knowledge that gnat (or mosquito) larvae breathe by thrusting a tube through the surface of the water that made human life possible in malarial places. A little oil on the surface clogs the tubes and suffocates the larvae.

and the distance to be traversed by the oxygen would be too great, for the oxygen is wanted all over the body of the sea-urchin. A plan has therefore been devised by which the water can be circulated through the urchin in canals so that no part of the body is very far from the circulating water. Thus the creature inside is, as it were, irrigated by a system of canals in each of which water is circulating and in each of which the water is either carrying oxygen to some part of the body or is returning for a fresh supply of it

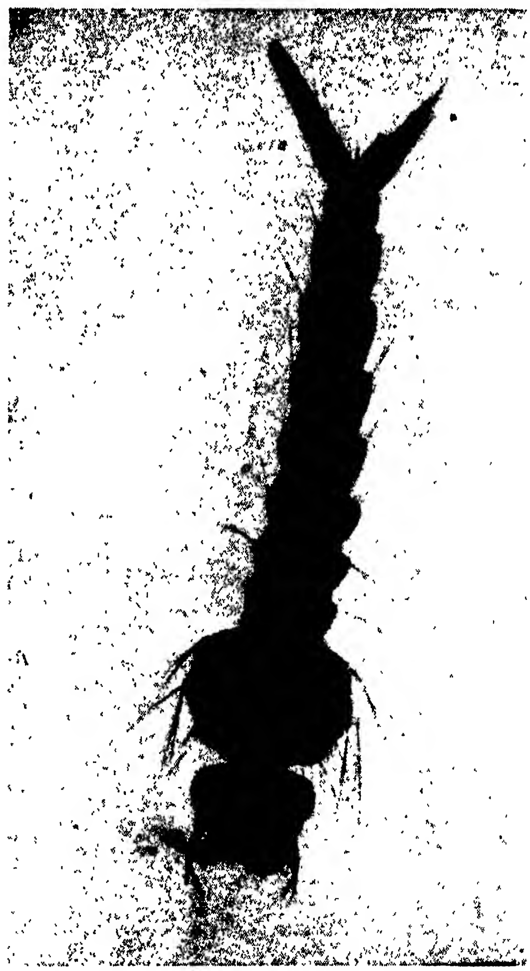
THE fluid spoken of as circulating in the channels of the sea-urchin has been spoken of as water. Essentially and for the present purpose it may be regarded as such, for its power of dissolving oxygen is much the same as that of sea water, but in reality it is something more than water, for if shed into a vessel it will clot. It is, in fact, a very primitive type of blood.

To turn to a much more highly developed form of marine life, the lobster, you are confronted with an animal of much greater activity, as may be evinced by the power of its claws. This power is the expression of a background combustion and therefore of oxygen used. It is therefore only natural to find that the provision for the oxygen supply of the tissues of the lobster is on an altogether more compendious scale than the primitive irrigation of the sea-urchin.

The fundamental principle of the system ot oxygen supply in the lobster is still one of irrigation. The advance wrought is largely one of degree. In the first place, the fluid which is driven through the various channels—channels which we may now definitely term blood vessels—is propelled by one definite pump, the heart. In the second place, there are very complete arrangements by which the blood can pick up oxygen from the sea water in which the lobster is living. These arrangements are gills of sorts, and may easily be seen.

The shell covering the back of the lobster is continued down over the animal's sides as two shields which, on their inner surfaces, are quite free from any attachment to the body. These shields of shell may be broken away and underneath them will be found numerous bodies which look like plumes. Each fibre of these feathery bodies contains delicate blood vessels within it. The blood is continually circulating in these, and is only separated from the sea water by a membrane so delicate that the oxygen has no difficulty in soaking through from the water into the blood of the lobster. The blood therefore comes from tissues where it has been denuded of oxygen, replenishes its store in the feathery gills and is driven once more to the tissues.

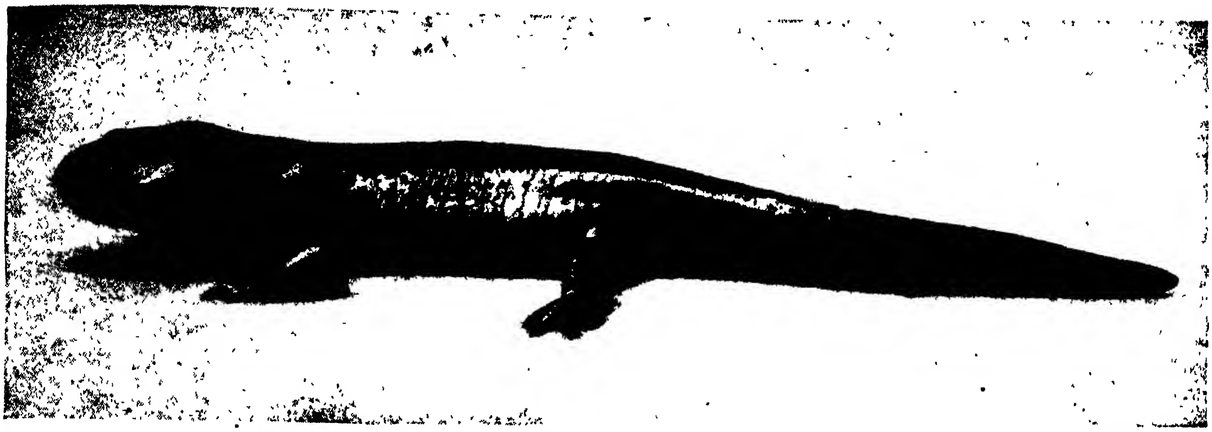
But the whole story has not yet been told, for in the blood of the lobster and others of its kind is to be found the germ of one of nature's most ingenious devices. Oxygen is rather insoluble in water; at best, when shaken up with air, water will only dissolve a little more than one two-hundredth part of its own volume of oxygen. Pity the poor lobster's heart, therefore, which, were it not for the provision



J J Ward

THE GNAT LARVA AND ITS BREATHING TUBE

The breathing tube of the gnat larva is joined to the eighth or penultimate segment of its body, and ends in five flaps. These, spread out upon the water, act as floats to keep it at the surface and also as breathing holes. The flaps are closed for diving.



W. S. Berridge

SALAMANDER THAT CHANGES ITS BREATHING APPARATUS

For many years the real life history of the American salamander, common in Mexico and found also in the Rocky Mountains, was not guessed at. It came as a great surprise to naturalists when the discovery was made that a creature called the axolotl, considered to be allied to the newts and living in the water, was really one and the same animal in an early stage of its development. The axolotl breathes under water by means of gills. But on leaving or being deprived of water the axolotl sheds its gills and breathes air.

which I am about to describe, would have had to propel quantities of water round the body, out of all proportion to the amount of oxygen which was transported therein.

NATURE found a chemical absorbent which could be dissolved in the water, and which when dissolved increased many times the quantity of oxygen which a given quantity of water could carry. This substance has the further remarkable property, namely, that when it arrives in the blood vessels of the tissues it generously gives up the oxygen which it has acquired in the lungs. The name of this chemical absorbent is haemocyanin, and it is a compound of copper.

In reality these arrangements for the absorption of oxygen and its transport are so efficient as to be capable of absorbing much more oxygen than would be in stagnant water immediately in contact with the gills. Therefore, the lobster has had to devise some way of securing a consistent stream of fresh oxygen carrying water over the surface of the gill-plumes. It has, so to speak, to ventilate the gills not with air but with water which contains air in solution. This ventilation is carried out in an extraordinarily ingenious way. The gills are situated, as we have already said, in a sort of tubular chamber which is formed of the body wall on the inside of this shell. On the outside, this tube is open at the front, or head, end, and also at the hinder end. Near the front end of this tube, attached to one of the legs, there is an object which bears some resemblance to a paddle—it is called a scaphognathite. This paddle is never at rest. Ever swaying, it maintains a constant stream of water over the gill-plumes.

The fight of the body for oxygen in all the higher animals, though much sterner, presents the same three-fold problem as in the lobster. First, how to provide a suitable site for the transference of the oxygen from the outside air or water into the blood. Second, how to transport the oxygen from that site (be it lung, gill, or skin) to every nook and cranny of the body. And third, how to ventilate the respiratory apparatus with sufficient oxygen for the blood to pick up. The problems of the respiratory system are no other than the problems of any system of intensive supply. You classify the provision of food for a large town along precisely the same lines. A means of bringing food to this place on a large scale—the railway corresponding to the ventilation ; a site for its transference to some means of internal transport—the goods station ; and a system

J. J. W.

DRAGON-FLY NYMPH BELOW WATER

At the hinder end of the dragon-fly nymph's body there are three pointed appendages which, when open, admit water to the region of the body filled with blood channels, where oxygen is extracted. The used water is then expelled and, if necessary, with sufficient force to drive the nymph violently along.

J. S. Cheavin

RESPIRATORY METHODS OF A WATER BEETLE

One of the common inhabitants of an English pond is the dyticus beetle (top). When it wishes to breathe it rises to the surface and waits there with the end of its abdomen in the air. It then raises the elytra or wing case and exposes a surface of its body covered with spiracles or breathing holes. The lower right photograph shows one of the spiracles, and the lower left illustrates the connection between the spiracle and the main tracheal tube in the wonderful breathing system of this creature of the pond.

of distribution which is capable of carrying it to every house in the town—the streets, vans, lorries, and so on—corresponding to the blood vessels and the blood circulating through them.

The necessity of adequate provision of all three components of the system of respiration may be judged from the fate of a certain section of the animal kingdom, which forgot one of the three.

THE insects are not so far removed in relationship from their jointed legged neighbours of the lobster family, but the insects "made the plunge," if I may be excused so inverted a metaphor, from life in the water to life in the air. By doing so they came into much closer touch with oxygen in bulk, but clearly the respiratory system which was designed for life in the water—the scaphognathite, the gills and the rest—were of no use for the air, so another system must needs be devised. The insect did rather the obvious thing. It laid down a system of minute air tubes all over its body. Such a tube, starting from the surface of the body, spreads into the interior like the branches of a tree (but hollow), ending in terminal blind twigs. The tubes are prevented from collapsing by a spiral of hard material in the wall. A very beautiful system, you say, extending to the furthest interstices of the body; true, but note there is no provision for getting the air in and out of the tubes!

When I go to my friend the dentist, I see a little flame on his table and in his hand an instrument which consists of a tube, the open end of which he puts in the flame; but the other end is fitted with a rubber ball. He gives the ball three or four squeezes, during which the hot air rapidly traverses the tube, and then the instrument is fit for use. Then I feel inclined to go to the insect with great deference, take off my hat and say: "Sir, why did you not put just such a ball at the blind termination of your breathing tubes, so that by making it pulsate you could perpetually be clearing the tube of the old air and introducing new?"

Well, I reflect that to suggest anything to nature would be an impertinence; but still the fact remains that if the dentist closed the end of his tube at which the ball is situated, the air could only change very slowly in the tube, and so it is with the insect, only in the part of the tube which is quite close to the orifice does the air change at any rate that is worth while. Therefore, to be of any use to the insect, every part of every tube must be near the orifice, consequently the insect never can become anything but small. The dragon-fly is among the largest of insects, but even it has a very "thready" body, long indeed but thin to a degree. Yet the insect life, though capable of great activity, must always be small because the insect has no provision for the ventilation of the air pipes.

It is when we consider the life of the higher animals—those with backbones—and especially the warm-blooded animals, that we see the provision for an oxygen supply on a grand scale. To take in three

J J Ward

ORGANS WHICH SUPPLY THE BLOOD WITH OXYGEN

These insects take in the air from which the oxygen is to be separated by a series of apertures, called spiracles, on either side of the body. In the lower photograph are spiracles of the gipsy moth. Above is a silkworm spiracle showing how the tracheal tubes branch from the spiracle itself into finer tubes and spread to all the body.

SPIRACLES OF BORDERED UNDERWING CATERPILLAR

In the caterpillar the spiracles by which it breathes are plainly marked all along the side of the body. This simple but very efficient arrangement allows the air free access to the blood supply without the intervention of any lung organ. The mouth is thus purely for feeding and, in the caterpillar's case, ever-busy

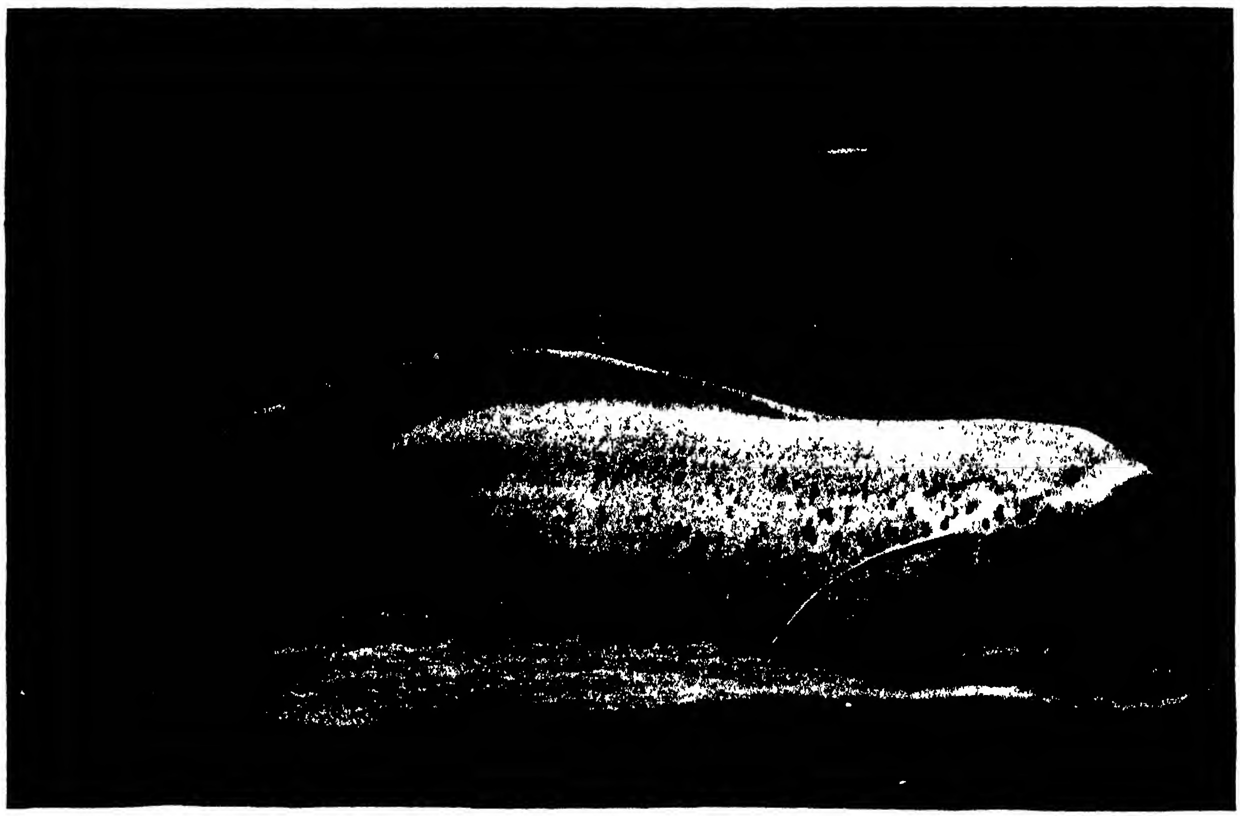
cardinal points, firstly as regards the seat of oxygen-exchange between the air and the blood, that in land animals is the lung. Each lung in man is essentially a number of bags into and out of which the air can be driven, but the wall of each bag is one vast honeycomb of minute air-cells into which the oxygen diffuses from the general cavity of the bag, and in the walls of which is a network of minute blood vessels. A vast area of blood, estimated at nearly a thousand square feet, is at any one time spread out in these vessels and separated from the air in the air-cells only by a delicate film of material sufficient to keep the blood from leaking out, but yet porous enough to allow of the passage of air.

The arrangements for inflation and deflation of the lung differ in different forms of life. In all cases they are carried out by some sort of rhythmic muscular movement operated by the brain. The frog fills its lung by filling its mouth with air, shutting its mouth and nose and then gulping the air down into the lung. The lung is deflated when the nose is opened, by its own elasticity. Possibly it is just because this method is primitive and not to be relied upon, that nature in the case of the frog is not prepared to risk too much on it. At all events, the frog can breathe through its skin and, therefore, is not confined to pulmonary respiration. The mechanism by which birds inflate and deflate their lungs is a little mysterious. The bird's lung, unlike the human lung, is not at the end of a tube, but consists really of numerous little lungs packed along the sides of a tube which again recalls the air syringe of the dentist. For at the end of this tube there is a large air sac which goes down the body, and indeed the bird has quite a system of air sacs. It is supposed by many that the bird, especially when it flies, draws air in and expels air from its air sacs with each rhythmic movement of its body muscles, as the dentist expels it from the syringe with each squeeze of his hand. Incidentally, the tubes on the way to the air sacs and the lungs on their walls become ventilated. It is not surprising that the birds have a very powerful respiratory apparatus. To force air out of the lung when flying at sixty miles an hour up wind cannot be an easy affair.

The animals with warm blood do not force air out of their lungs—at least, not to any great extent. They draw it in and, in a measure, allow it to come out of itself. In them, as in the birds, interest concentrates largely on the brain's respiratory rhythm. The part of the brain which is responsible for the respiratory rhythm works automatically like a fly-wheel. If the respiration is too violent, the blood will alter in composition, and the altered blood when it arrives at the brain soothes it and makes the respiration more quiet. Again, if the respiratory efforts are not strong enough, the composition of the blood again suffers, and the impure blood stimulates the brain to drive the respiration with still greater energy.

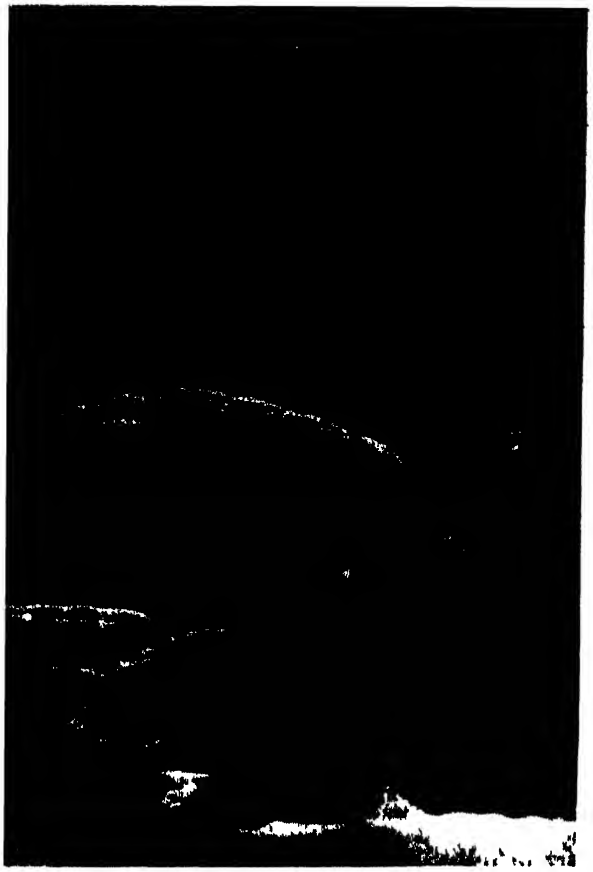
A few words in conclusion about man himself. In him the fight for oxygen is more exacting than in any other creature, for man lives to a much greater extent on his wits than do the brutes. By his " wits " I mean the accurate and detailed action of the thinking parts of his brain, and it is these which suffer first if there is deficient oxygen supply. So sensitive is the brain to complete deprivation of oxygen that consciousnesss can only last a few seconds. After all, oxygen has been prevented reaching the brain. There is in the lungs about two minutes' supply of oxygen and perhaps a minute's supply in the blood, so that the faculties can be maintained for a short time after the complete cessation of respiration.

The persons who carry the fight for oxygen to its most extreme limits are the pearl divers of the South



REMARKABLE FISH WITH DUAL SYSTEMS OF BREATHING

The lung-fish have adapted themselves cleverly to circumstances. The rivers in which they live dwindle to a greater or less extent in the dry season, and leave only a chain of pools. Species like the African mud-fish (bottom) make a hole in the mud with an aperture at the top and breathe air, remaining dormant till the rain shall fill the rivers again. They use the air-bladder common to all fish as a lung. The mudskipper (top), also African, walks and skips about ashore and is said to use its tail as a respiratory organ by leaving it hanging in the water.



WATER CREATURES THAT BREATH AIR

While being essentially of the water the sea lions (bottom) have not, in the wonderful course of evolution, made any attempt to adapt their breathing apparatus to under-water conditions, but must rise, just as the turtles must (top), to the surface for air.

FEATHERY GILLS OF YOUNG NEWT

During its early life the newt breathes by means of gills which are feathery-looking appendages. We see them here at their greatest development. As it gets older these gills disappear until the newt finally leaves the water and becomes air breathing

Sea Islands—the woman pearl divers to boot. A traveller reaching one of these islands in a yacht has recorded the extent to which these women have reduced oxygen want to a fine art. They dive to the bottom of the sea, search for the pearls and time their stay with such nicety as just to have reached unconsciousness when they are at the surface. Still unconscious, they are dragged out of the water, laid out on the beach to regain their faculties, and, having done so, they smilingly make another excursion to the bottom.

But the fight for oxygen is not left to savages; civilization fights as well, and in the following way. Man is ever trying to push upwards, even in the literal sense of the word. The spirit of conquest impels the ascent of Everest, the search for rich mineral deposits drives him to carry out mining operations 16,000 feet up the Andes. Victory over the air sends him far above the clouds in 'planes. As he ascends he is ever getting into rarer and rarer atmospheres—that is to say, into atmospheres which contain less and less oxygen per cubic foot. Then he fights. The deficiency of oxygen in his blood drives his brain so that he pants, and in time he achieves a partial success; the want of oxygen also drives the factories of his blood so that it becomes richer in the red pigment, haemoglobin, that in all higher animals acts as an oxygen carrier; herein he achieves another partial success. The poverty of the air also makes him expand his chest, so that the races which live high in the Andes appear almost to be deformed, so large is their chest development—a third success. And other more subtle changes take place, all of which are, in one way or another, the response of the organism to deprivation of its most immediate necessity—oxygen.

Chapter XLVIII

The Mystery of the Salmon

By Hamilton Fyfe

"THE salmon," wrote Izaak Walton in his "Compleat Angler," "is accounted the king of fresh-water fish." He wrote with careless, happy assurance. He was confident that he knew all about the salmon; that it was beyond question a fresh-water fish. Yet in his day very little was known about it and in ours not much more.

The title which he gave it has not been disputed. It is a king of fish, a favourite equally with anglers and with those who enjoy the pleasant flavours of food. There are some who say that salmon is difficult to digest. Perhaps it has been blamed sometimes when the cause of trouble lay in reality elsewhere. Mr. Snodgrass (in "The Pickwick Papers") murmured on one occasion in a broken voice: "It wasn't the wine, it was the salmon," when it really was the wine and not the fish. There is no doubt that salmon is highly nourishing; there is little danger of its causing digestive trouble if it be eaten moderately and not mixed with other rich substances.

It is to-day found on a very much larger number of tables than ever before. Its pink flesh, once a luxury for the well-to-do, has become an everyday article in the diet of the poor. True, the fish which are canned in enormous quantities on the Pacific Coast are not like those which are caught in Scottish or Irish rivers or in Norwegian lakes; they are smaller, they have not the same flavour. Yet they are salmon, they belong to the same species, there is the same mystery about them.

In the animal world are many unexplained wonders. We find certain creatures with habits which are peculiar to themselves, habits which they must have acquired for some reason now only to be guessed at. For example, the huanaco (or guanaco), a South American animal something between a goat and a deer (not at all like a "camel without a hump," as it is described by some writers) goes always to a particular place to die. No one has been able to trace this instinct to its origin. The suggestion has been made that in past ages when the South American continent was colder, the huanaco may have been driven by storms to shelter among the reeds and trees growing beside rivers in deep valleys, and that now it still seeks its Valley of Death when it feels discomfort and pain arising from causes other than the climate. But that is no more than a surmise.

Not any less puzzling is the salmon's habit of living partly in fresh water, partly in the sea. This is made even more difficult to understand by the fact (if it be a fact) that salmon do not feed while they are in fresh water, or at any rate feed very little. The usual emptiness of their stomachs when they are caught has been attributed to their vomiting from fear or anger as soon as they feel the hook in their jaw and are being dragged towards the bank against their will. But this remains a suggestion.

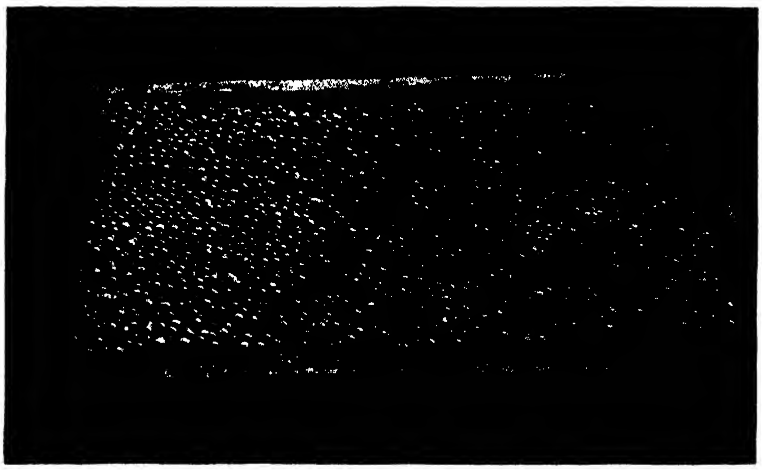
It has been pertinently asked: "Why, if salmon do not feed in rivers, do they snap at the fisherman's fly?" The reply made to this by the naturalists who maintain that they live on their own fat during the periods of their absence from the sea is that they take the fly merely from curiosity. That again is but a theory. Against it has been set the probability that if they snap at an artificial fly they must be accustomed to snapping at real ones, and therefore to feeding. Yet the examination of stomachs has shown pretty conclusively that it is not their custom to take

&NA

SCALE FROM A SALMON

This scale was taken from a mature male fish in its fourth year. The rings, shown clearly by the magnification, are an indication of the age of the fish. The tint of the scales varies considerably, being bright before, and dull after, spawning

W. S. Berridge



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EARLY STAGES OF THE SALMON'S LIFE

The salmon fisheries being a very important industry the eggs are carefully collected and sent from rivers where the fish are plentiful to those worse stocked. About 100,000 can be packed in one of these cases (bottom), and the eggs can remain for several weeks if kept moist and cool. Above is a salmon in the "parr" stage.

nourishment regularly in fresh water. Another doubtful point is whether salmon return always to the rivers where they came into being, and where their first year of life was spent. They seem to do this as a rule, but the rule appears to be variable.

One thing seems sure among many incertitudes. The eggs of salmon will not develop in salt water, nor even in large bodies of fresh water. They must be deposited near the source of a stream, in pure water flowing quickly over a gravelly bed. This explains the astonishing determination shown by salmon in ascending rivers. Nothing more resolute than their will to reach a suitable spawning place is known in nature. It is usual now in Britain to assist them by putting in salmon ladders or passes wherever a sudden rise in a river level makes ascent specially hard. Even with such help they cannot go forward at a rate more rapid than from eight to ten miles in a single day.

Their leaps are prodigious; from their trick of jumping clear of the water they get their name (Latin, *salire* to leap). In the rivers flowing to the Pacific Ocean, where they ascend in dense masses, their struggles are pitiful. Vast numbers leap out of the water and die on the banks. In the water they are in places so thick that they appear to be a solid body. So imperious an instinct is rare. It is among the most arresting wonders of animal life.

The career of the salmon is on this wise. It begins as a wriggling, shapeless, tiny creature, not unlike a tadpole. Since it has no mother to suckle or feed it, it is provided with a bag from which it draws its nourishment. It is called an *alevin*. After two or three weeks it has grown to the length of an inch and become a *samlet* or salmon fry. For centuries these have been in England under the protection of the law. As far back as 1533 an act of Henry VIII declared that "no manner of persone shall take at the tayle (tail) of any mylle (mill) or were (weir) the yonge fry of salmon." Thanks to this care for their welfare and the fact that they are so small, the baby

salmon seldom fall a prey to man. They are frequent victims, however, of fish; their own species even is said to devour them, though this is another topic of controversy. Other fish certainly do. But there are a great many samlets; large numbers escape all perils and at the age of a month or six weeks they grow into *parr*, four inches long and very lively.

UNTIL less than a century ago parr were believed to be a separate species of fish; only in 1837 were they discovered to be growing salmon. They grow steadily but not rapidly. Their life settles down to a long, gradual development. Not until they are from fifteen to eighteen months old do they reach the next stage and become *smolt*. Now they make their first journey to the sea, where, if they are lucky enough to reach it, they soon have silvery scales and begin to look like grown salmon.

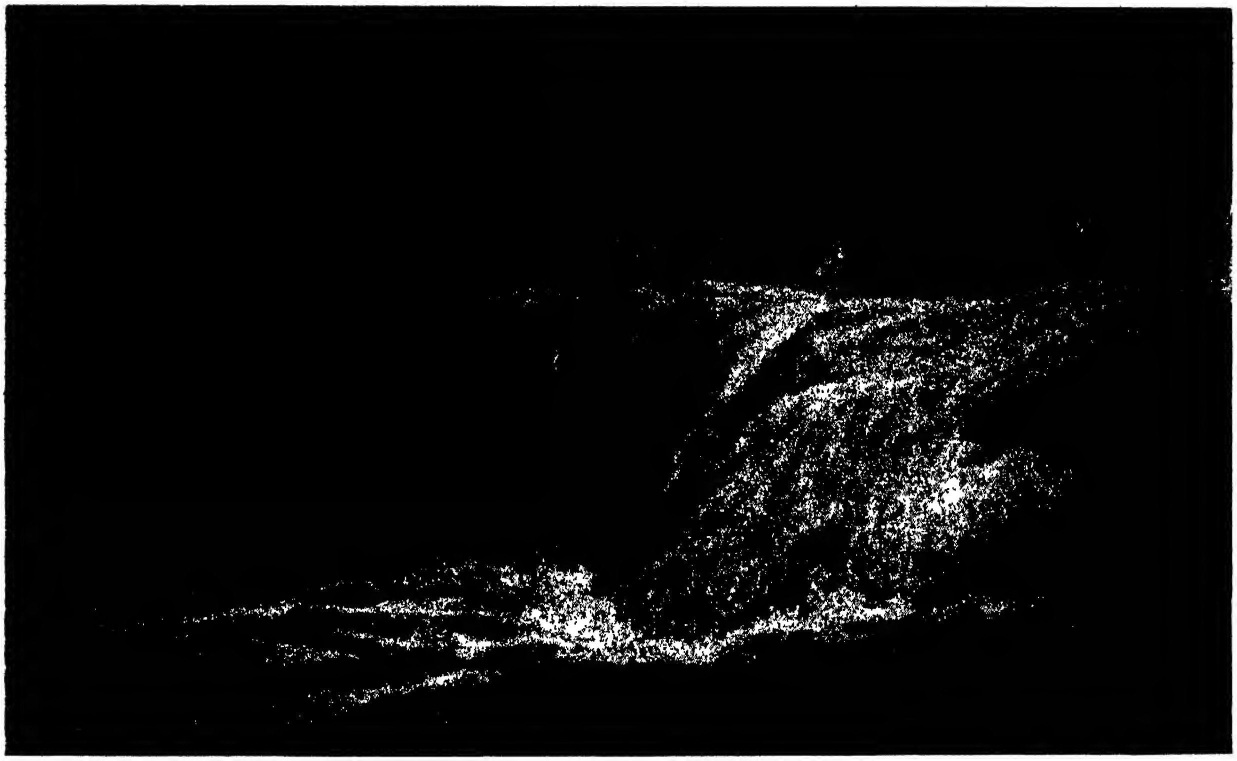
ADOLESCENT AND MALE SALMON W. S. Berridge

When the fish are ready for spawning the male becomes very pugnacious and develops a great hook on the lower jaw (bottom). After spawning is done the jaw loses this asymmetrical appearance. The upper photograph shows a young salmon. At the end of three years the fish loses its parr markings and becomes a silvery "smolt."

But the perils of the journey reduce their number to a meagre fraction of that which set forth. At first they are snapped at by voracious pike; herons drive at them with rapier-like beaks. Then gulls swoop down on them and large hungry sea-fish harry them. Only the strongest and the most fortunate escape from so many fierce and greedy foes. Those which do find themselves safe in deep water, for which they always make at once, grow in a few months' time into *grilse*, their last stage but one.

Many salmon in this stage leave salt water and go up rivers along with the fully matured fish, in order to breed as a rule, though not, it is said, invariably for that purpose. Other grilse, not so precocious, remain in the sea until they are mature.

The salmon which ascend rivers are divided into *baggits* (females) and *kippers* (males). Both have in the period before spawning a most unpleasant appearance. The females are almost black and are bloated and bulky in shape. The males are of a dirty red colour, spotted and slimy of skin. Their shoulders have shrunk, making their heads seem enormous. Their jaws have lengthened, they display dangerous-looking teeth, they have formidable curved beaks. These are for no other purpose, it would seem, than



GROUP OF SALMON TAKING A DOUBLE FALL ON THEIR WAY TO SPAWN

When the rush and drive of these boiling waters, swollen high with winter rains, is seen, then the amazing energy of the salmon can be understood. For months the fish has been swimming the sea—its true home—laying up fat and strength for the great trial. But when the hour comes the fish seems to exult in its own strength and the task before it. Here we see that not only one jump must be made but, immediately upon regaining the water, another to surmount this double obstacle.

to fight with. Combats between the kippers are frequent. Darwin noted in the "Origin of Species" that male salmon had been observed fighting all day.

The female prepares a nest for her eggs by making a deep trench in the river bottom with her tail, then she lays them gradually, the kipper fertilises them, and as soon as they have undergone this process they sink into the gravel. Eggs which are not fertile float and are snapped up by fish which wait for them below the salmon nests.

The hatching takes from seventeen to twenty weeks; the warmer the water, the shorter the time. The tiny creatures which emerge from the eggs stay for a fortnight or so under a rock or stone for protection. They get no help or instruction from their parents. They have to shift for themselves. The older fish do not even wait to see how they get on; as *kelts* (in Ireland *slats*) they go down stream as quickly as they can to recover themselves in the sea after spawning. When they have regained their handsome appearance, they are known as "clean" salmon. They remain "clean" until they are again under the influence of the urge to reproduce, which sets them ascending a river again (though some, it is contended, go up without spawning).

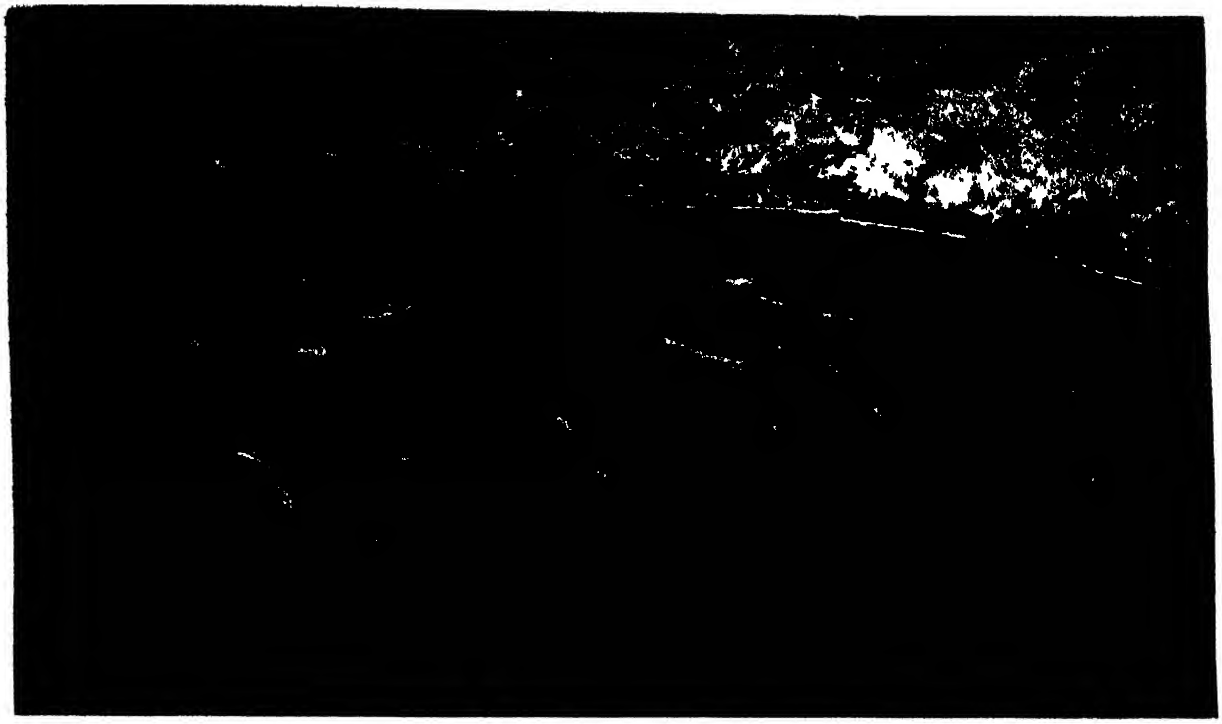
Many do not feel this urge a second time, very few a third time. It is held to be very uncommon for a salmon to "run" more than twice. The great number probably go up rivers to breed only once. This can be learned from their scales, which tell something of their life history. It has been discovered in this way that sometimes they stay in the sea for as long as three years before being seized by the impulse to seek fresh water. This is felt in the autumn or winter. The spawning season is from September to January. In British rivers salmon spawn usually in November or December, sometimes as late as January.

There is a belief among certain naturalists that adult salmon do not "run"; that fish in the grilse stage are the only ones which ascend rivers, and that they do so for the sole purpose of spawning. But this view obtains little support. It is mentioned in order to show how diverse are the opinions concerning salmon and how little there is in their life history about which all who have made a particular study of them are agreed.

One statement may be made without fear of contradiction. Pacific salmon furnish the most valuable catch of fish in the world. Not even the herring, a poor relation of the salmon, can compete with it as a source of wealth. The Pacific variety is distinct from the European. It is called sometimes the hump-backed, sometimes the dog salmon. There are many slightly differing types of it and these are netted in vast quantities; they are canned on the spot and sent to many lands.

SALMON FIGHTING ITS WAY UP THE FALLS TO SPAWN

face page 496



The Pacific salmon are of no interest to anglers. They do not rise to a fly in the rivers, as European salmon do. Their flesh is not so delicate; it is red rather than pink (both colours are the result of eating certain kinds of shell-fish); they are not so "kingly" in their aspect. The scenes in the rivers and on the banks of rivers when the salmon are in spate have been noticed already. A British Columbian writer says they actually stop the course of mighty streams.

K N A

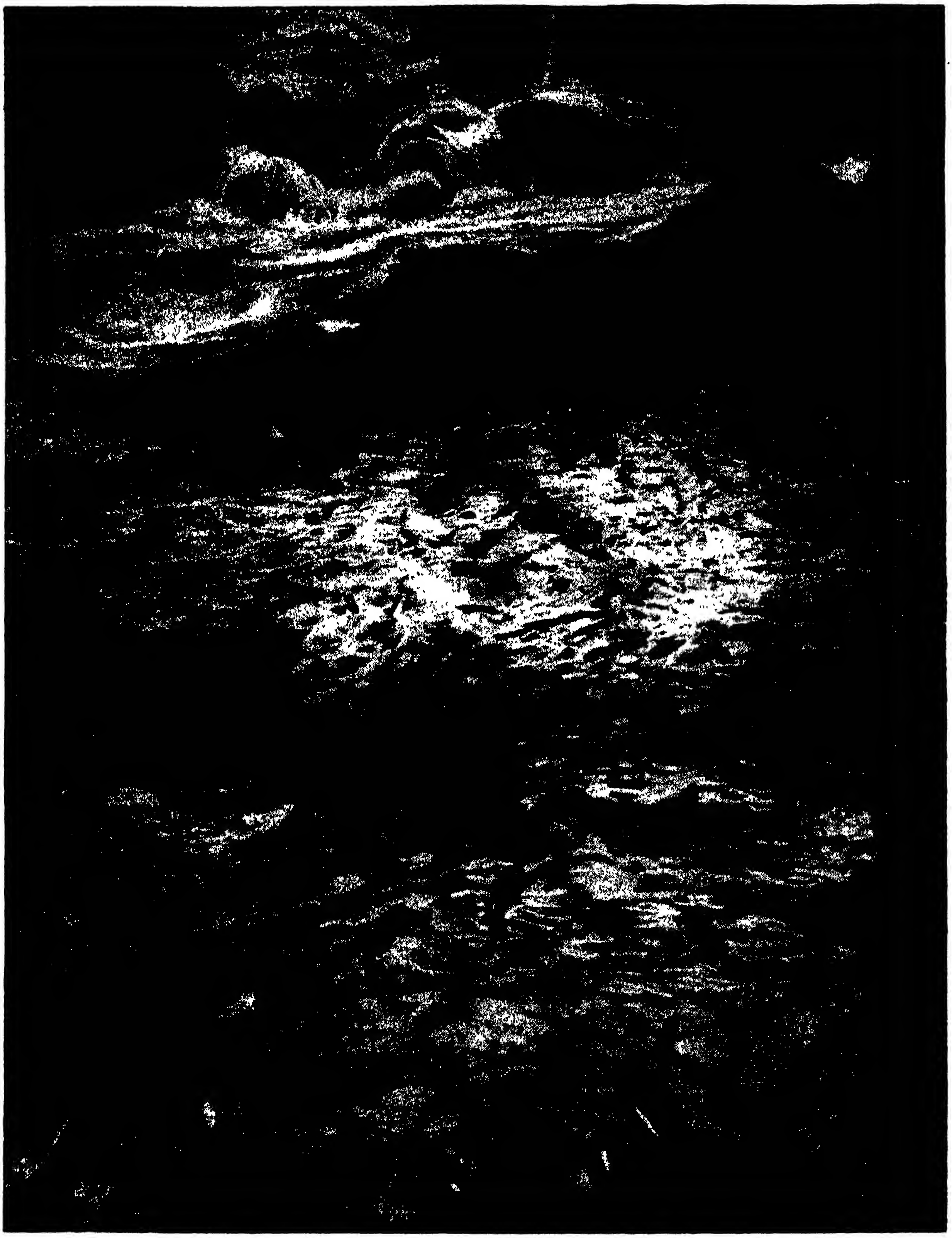
SALMON THWARTED BY A LANDSLIDE: SPAWNING FISH

Below is a silver horde whose invasion was stayed by a landslide into the creek up which they have been making their way. Construction operations on a Canadian railway were the cause Above are some thirty fish engaged in spawning in gravelly shallows Salmon eggs must develop in cool water and this they get in the upper waters.

LAKE salmon are found in Canada, in the State of Maine, and in Norway. These have the same habits as those which live mostly in salt water. They ascend rivers to spawn, evidently being aware, as the others are, that they must lay their eggs on the gravelly bed of a shallow river. This seems to point to the probability that the salmon was originally a river fish which somehow or other acquired the habit of going down to a large body of water, either salt or fresh. to recuperate after the exhaustion of spawning.

Yet here we are met with the difficulty of explaining why the salmon does not feed in fresh water (unless it is an inhabitant of a vast lake). Its practice of living for a long time, while it is in a river, on what it has stored up during a period of roaming in more ample waters, suggests that it must originally have been a sea fish. But if we accept that view we have to supply reasons for (*a*) its invariable custom of ascending a river in order to spawn; and (*b*) the fact that its eggs will not develop in sea-water.

Thus, whatever hypothesis we are disposed to adopt, we find ourselves still wandering in perplexity. No theory seems to fit all the circumstances. The problem of the salmon, a mystery over which naturalists have argued for years, remains unsolved.



"RUN" OF SALMON MAKING UP-STREAM IN AN ALASKAN RIVER

Where food is plentiful there the fish are plentiful, and a good rule for judging the possible abundance of salmon is "the larger the river the more and bigger the fish"—other things being equal. In the rivers of North America the Pacific salmon teem. A good idea of the amazing number which appear in these streams can be had from a study of this photograph. They are resting in a pool below the falls preparatory to continuing their strenuous way to the upper reaches where their exhausting and prodigious journey will find its end.

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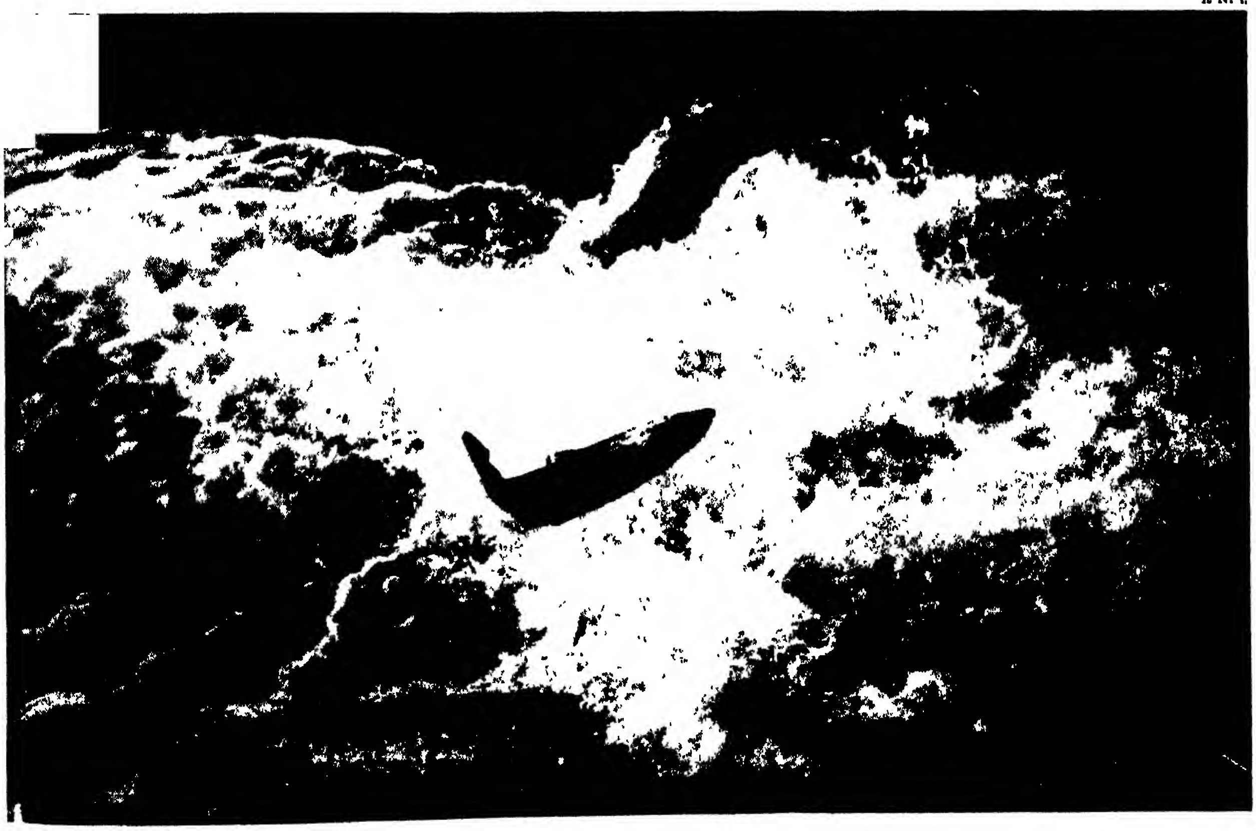
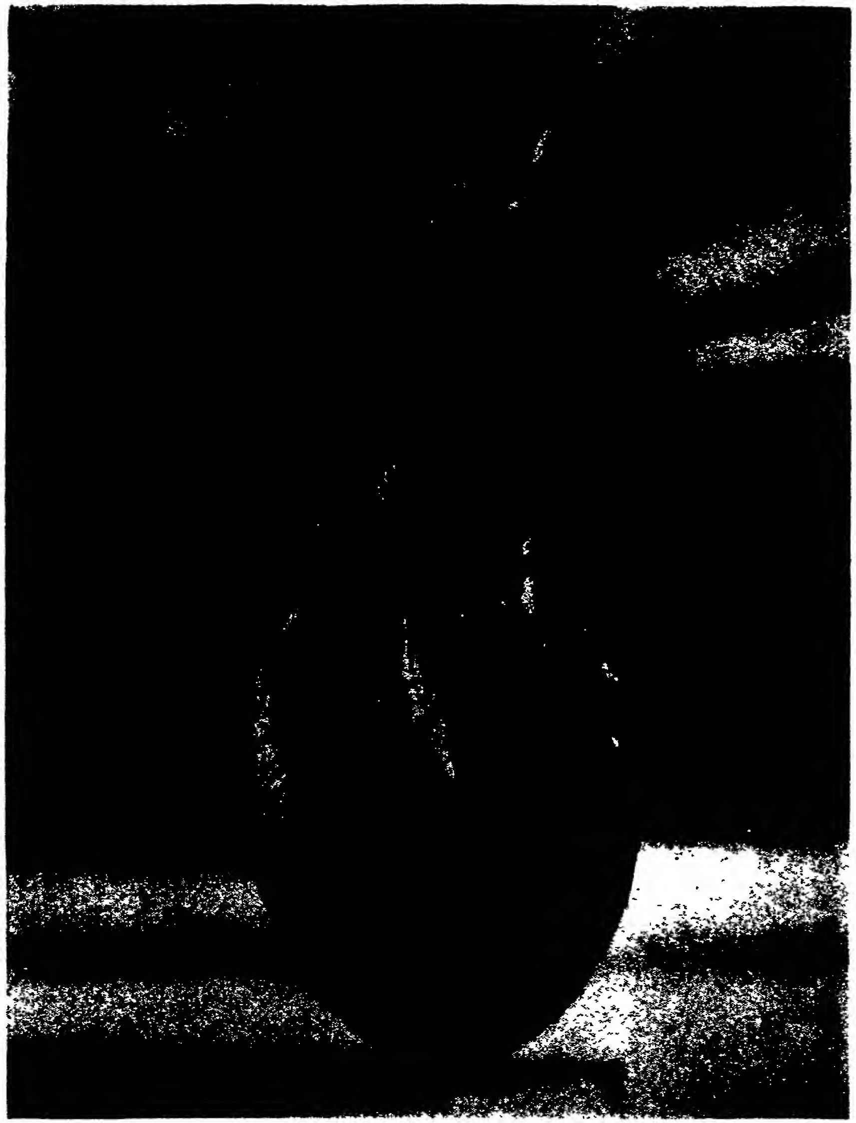


IN SCOTLAND OR ALASKA THE SALMON'S URGE UP-STREAM IS ALL POWERFUL

Where in the British Isles one may see a single salmon leaping, in a North American river which flows to the Pacific one may count a hundred. Indeed the numbers are so great and the urge, which drives this furiously struggling mass towards its destiny, so strong that hundreds get stranded in shallows and upon the banks where the wild animals snap them up. Below is a Scotch salmon making its leap, and above a fall at the outlet of Lake Brooks, Alaska, where it is estimated that twelve hundred salmon make the leap in an hour.



Neville Kingston

W. S. Berridge

ANIMALS THAT HANG THEMSELVES UP ON THEIR TAILS: OPOSSUM AND KINKAJOU

Opossums occur in America only, though from fossil remains it is evident that their distribution was almost world-wide in other ages. Nearly all the various kinds possess long prehensile tails which serve them as an extra limb in their arboreal life. Notice that the specimen here (left) is unconcernedly supporting its whole weight with its tail as it hangs from its keeper's finger. The kinkajou is also peculiar to the New World, and is confined to Central and tropical South America. We see it in a typical attitude, hanging by its tail from a branch. The animal is about the size of a domestic cat, and is covered with a soft, yellowish fur. In Australia the name opossum is given to the phalan[ger]

Chapter XLIX

Strange Tails and their Many Uses

By Frances Pitt

Author of "Wild Creatures of Garden and Hedgerow"

Many and strange are the tails of the animal world, varying from tails big and useful, such as that of the kangaroo, tails wondrously beautiful, such as those of some of the birds of paradise, to little insignificant tails like those of the deer and rabbits, which for all their insignificance are of importance, their owners using them as danger signals. Then there are tails which are weapons of offence, such as the powerful one of the crocodile, and the armed one of the sting ray; tails that are used to give warning, the rattle of the rattlesnake being a good example; tails with which the owners balance themselves; tails that are used as rudders; and last but not least the bird's tail as used in flight, when it becomes both an elevating plane, a brake and a rudder.

It is impossible to exaggerate the importance of the tail in the animal world, or the myriad uses to which this appendage is put. It is at no time more conspicuously useful than when it becomes a fifth hand, as in the prehensile tailed monkeys, in which it is as sensitive as a tendril, being used to wind round the branches and anchor its owner, while he uses his paws for one purpose and another.

It is curious to meet the prehensile tail again in a creature so far removed from the Primates as one of the rodents, yet the tiny European harvest mouse, a wee animal not so big as your little finger, has a wonderfully sensitive tail, which it uses to good effect when indulging in acrobatic feats among the corn. I have seen this tiny sandy-coloured mouse sitting on a swaying ear of wheat, its tail around the corn head, happily washing its face.

In the kangaroos and their allies the tail becomes a jumping pole rather than a fifth leg, its strength and springiness enabling the animal to take enormous bounds. There is a somewhat analogous development of the tail among those little desert animals the jerboas, which have a long tail and use it to take what, in consideration of their size, are very long hops.

Both the jerboa and the kangaroo use their well-developed tails as supports, taking their ease by resting upon them as we do upon a shooting stick, and certain birds use their feather tails in the same manner. I am alluding to the woodpeckers, tree creepers and their relatives. In these species, the tail feathers, though comparatively short, are very stiff and strong, and do not "give" when the bird presses its tail against the bark of a tree and rests its weight upon them.

With a few exceptions tails are a great feature in the bird world, being often marvellously decorative as well as useful. Sometimes they are more beautiful than useful. The peacock's train is, of course, the best known example; that great feather fan, with its array of gleaming eyes, which he erects in an iridescent halo about him, and sets a-quiver until every eye seems alive, is indeed a marvel. To be accurate the peacock's train is *not* a tail. The true tail consists of plain grey, rather stiff feathers, behind the ones we admire so much, which latter are really tail coverts, but so developed and elongated as to have lost all likeness to the uninteresting feathers that serve that purpose in most birds. But for practical purposes we may call the peacock's train a tail, and a marvellous one at that.

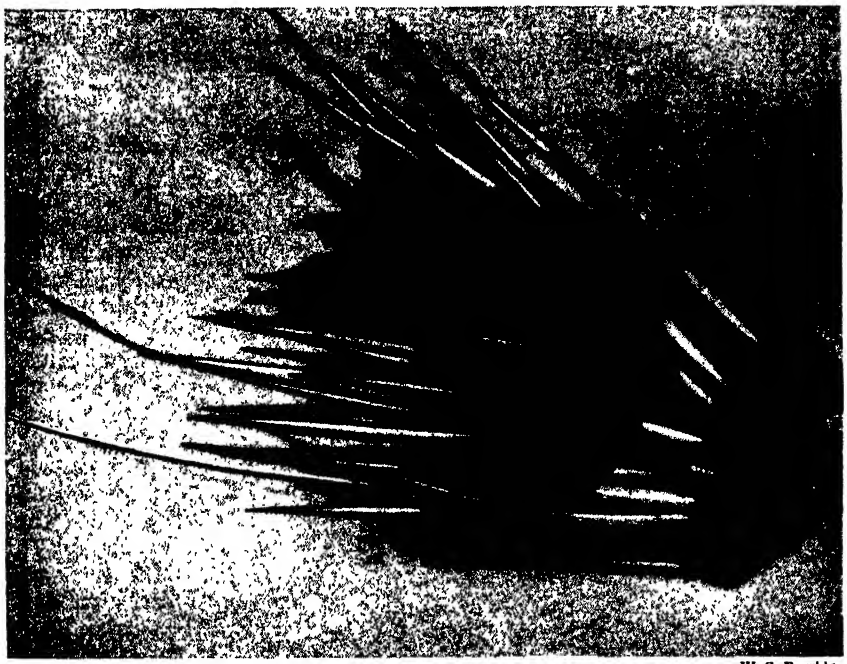
Why has the peacock got such a wonderful tail? The generally accepted theory is that it is to please his mate, and that the peahen always chooses the most beautiful cock; hence selection by the female has brought about the handsome

W. S. Berridge

RING-TAILED LEMUR FROM MADAGASCAR

Lemur tails are never prehensile, but the ring-tailed lemurs have very handsome tails which serve to balance them among the boughs in which they live. They are nocturnal, and the name lemur, which in Latin means a ghost, is an allusion to their stealthy ways.

F. W. Bond



W. S. Berridge

WARNING RATTLE OF PORCUPINE AND SNAKE

To warn all who may approach near enough to suggest attack, the porcupine can rattle the quills in its tail (bottom). The rattlesnake is famous for the warning apparatus on its tail. The snake does not want to waste its precious poison to defend itself if the rattle will do as well. The rattle itself consists of a number of horny cups, loosely but securely attached to the tail.

appearance of the male. In any case, it is unquestionably a rule of Nature that if a cock bird has fine feathers, he must let his lady see them, and this especially applies to fine tails. Many cock birds spread their tails fan-wise when displaying before the female; the turkey and black cock or black grouse are examples.

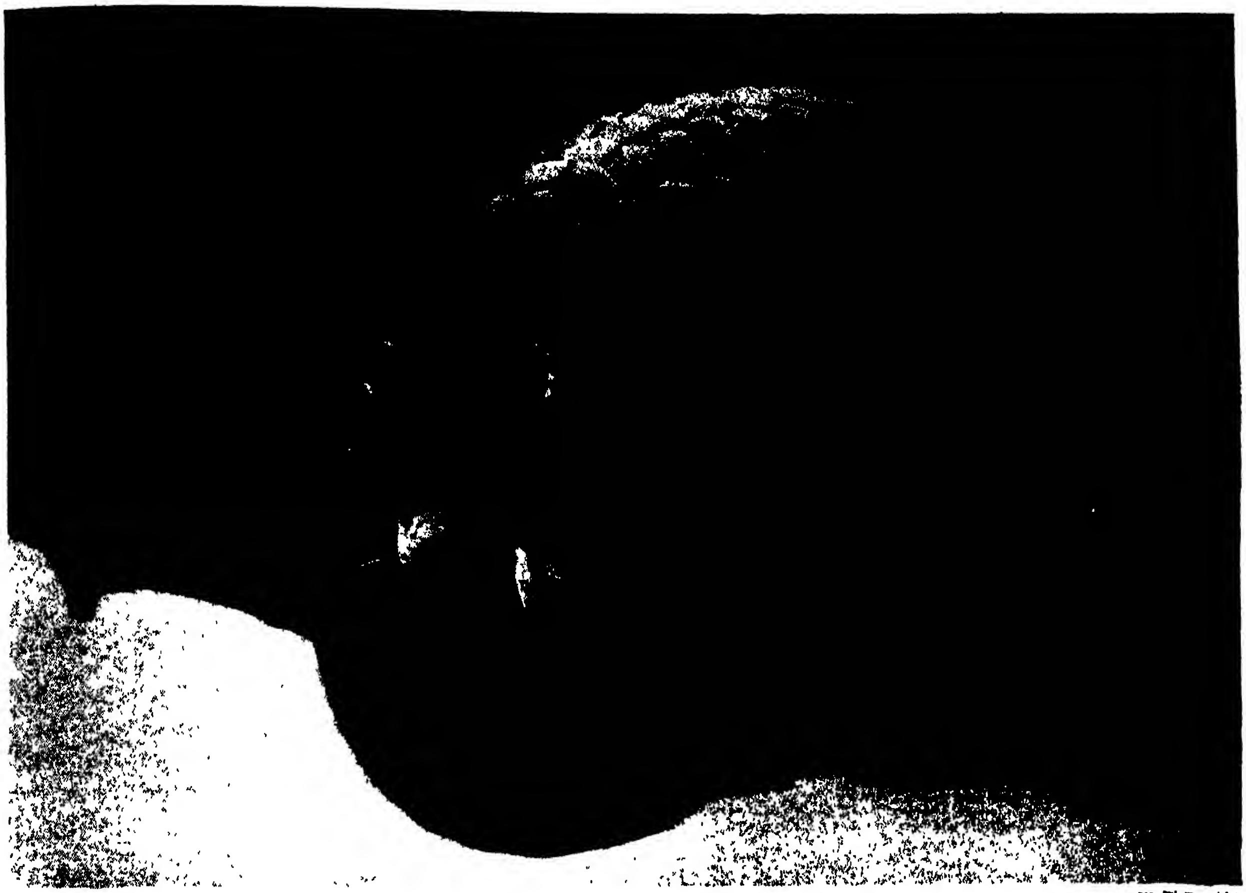
Some of these decorative bird tails are lovely as regards shape, but others owe their beauty to colour alone. The well-known African grey parrot has an ordinary tail as regards length, but it is of a beautiful rosy hue. The lyre bird gets decorative effect by the peculiar development of its tail feathers, as is the case with some of the birds of paradise, and others, but these latter often combine colour and form with most striking results.

One of the strangest of tails is that of the Japanese long-tailed cock, wherein the curved feathers, seen in the tails of the cocks of our poultry runs, grow many feet in length. This long-tailed fowl is a freak, or mutation, which has arisen under domestication, and we may surmise that it is due to the loss of some factor regulating feather growth in normal birds.

Reverting to useful tails, one has only to watch a bird in flight to realize how essential the tail is to it, enabling that bird to steer and turn, descend and rise again, check itself, and alight gently when it wishes to come down. I watched a kestrel hanging in the wind, maintaining its position on quivering wings, the while it scanned the ground beneath for mice, and I noted particularly the part played by its tail, widespread and a-quiver all the time, the bird using it as much, if not more, than its wings.

But important as the tail is to the bird, it is of even greater utility to the mammal, the fish, and other vertebrates. They put it to such an extraordinary diversity of uses. As a striking example, take the fat-tailed sheep kept by the natives in some parts of Africa, which, when it has plenty to eat, not only gets plump about the body, but lays up quantities of fat in the tissues of the tail, where it is retained as a useful store of nutriment when food is scarce and times are bad.

Perhaps no mammalian tail is more truly useful than the fly whisk of the horse and of the ox. Watch cattle and horses on a summer day and note that their tails are in incessant motion, ever swinging to and fro, whisking here and there, and keeping the worrying hordes of insects from their owners' flanks. A few moments' observation of horses and cattle when turned out in the fields will convince any one that their tails are not only most valuable appendages but possessions they can ill afford to part with, and that the docking of horses is a cruel fashion, especially in countries where flies carry horse diseases, and the docked horse is entirely at the mercy of his winged foes. Now the thick-skinned animals, such as the



W. B. Berridge

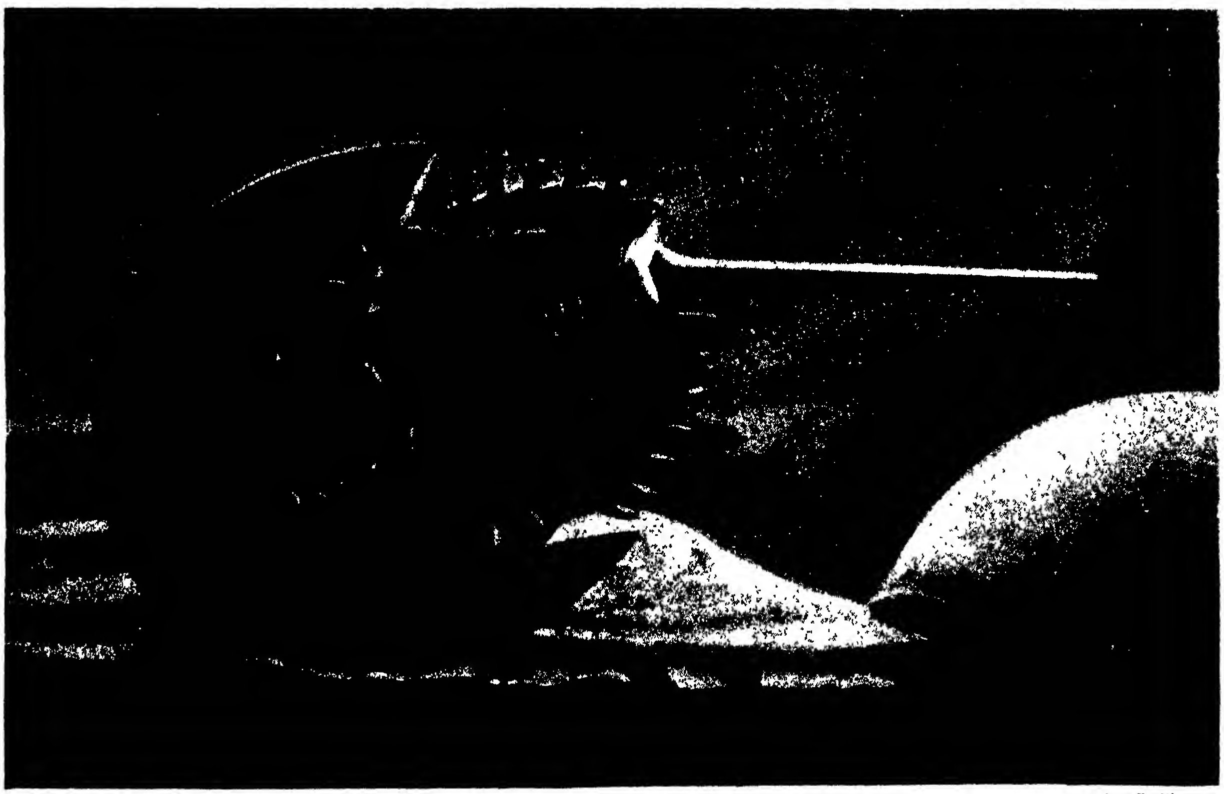
elephant and rhinoceros, do not suffer so much from the worrying attentions of flies, and so in their case the defensive fly whisk is reduced almost to vanishing point. It is the same with the familiar pig. It has a good thick hide and flies are no menace, so its tail is correspondingly reduced.

The fashion that calls for the removal of a terrier's tail is quite as silly as that which leads to a horse being deprived of its fly whisk. It is true that the tail is not so essential to the dog as the horse, but it is extremely useful none the less, being a great help in balancing and turning quickly, to say nothing of its function as a danger signal in emotional outbreaks. The angry dog who advances growling with his bristles erect and tail up lets his foe know how seriously annoyed he is, and it is that "flag" which helps to convey the information and, incidentally, intimidate the approaching enemy.

It is the same in the case of the wolf, and the full brush of the fox is a particularly good rudder, the word "rudder" signifying here that it helps the animal to turn; in the case of the otter and certain other aquatic animals, the tail helps tremendously as a steering instrument. But for its long, thick, strong "pole" the otter would not be able to turn under water as it does. As it is, it turns, twists, and doubles in its own length, much like a fish.

E. J. Manly

HOW PANGOLINS USE THEIR TAILS
In this extraordinary posture the African pangolin (bottom) takes its ease, and it can be seen how the very long tail makes this possible. The characteristic pose and use of the tail of the Chinese pangolin (top) is, however, quite different.



Neville Kingston

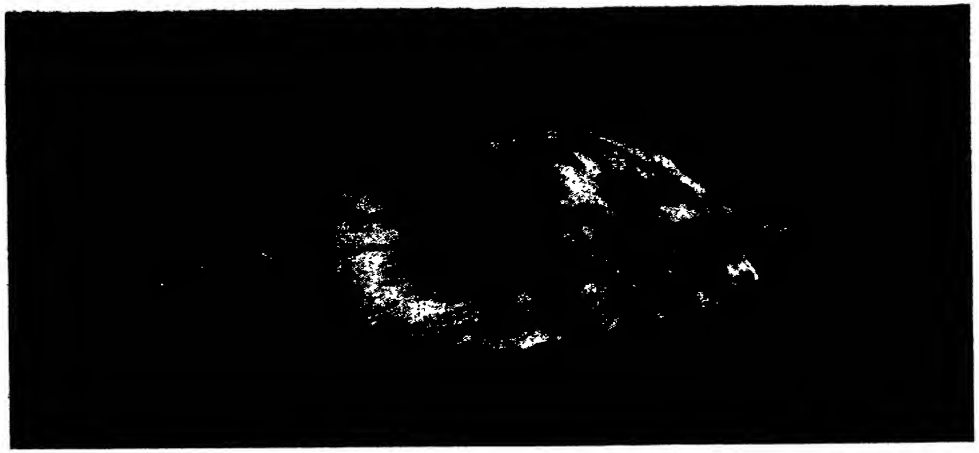
KING CRAB, DOG, AND ALLIGATOR, AND THE TAILS THEY HAVE

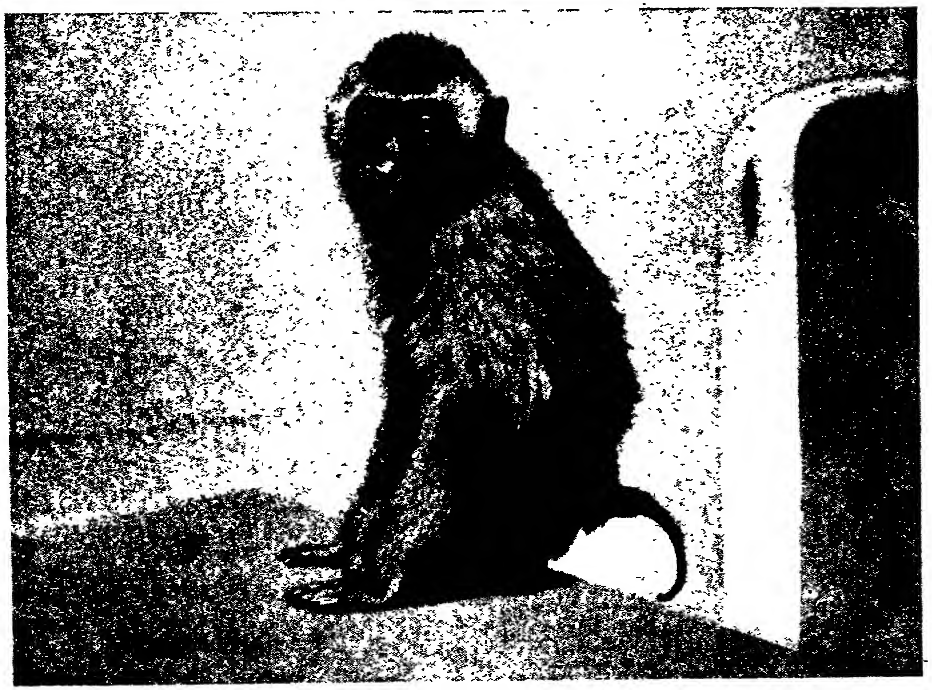
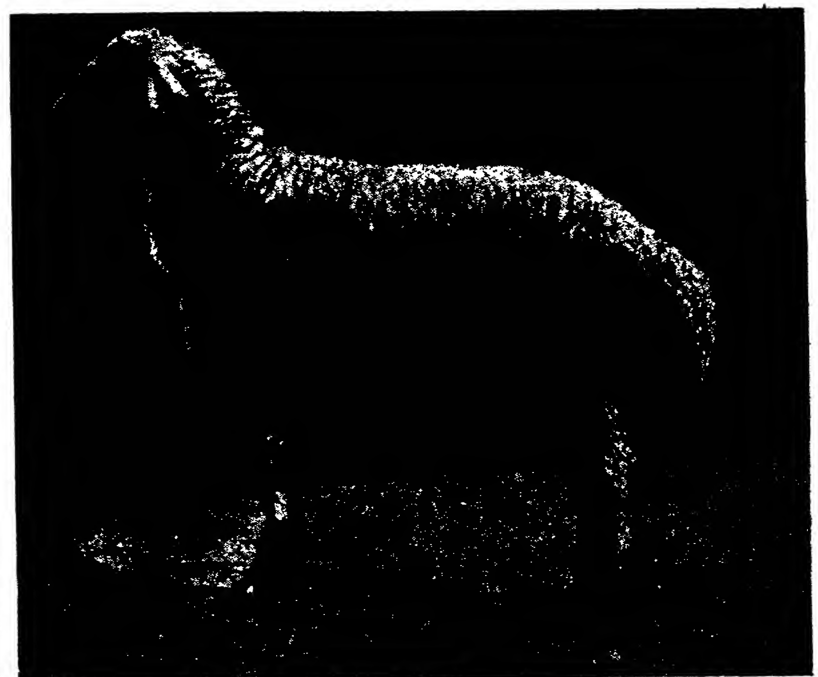
The king crab (bottom) puts its tail to a very practical, not to say a vital, use; for, while it is almost invulnerable when the right way up owing to its formidable shell, when turned over it is at the mercy of the first enemy. Therefore the crab uses its steel-strong tail as a lever by means of which it can turn itself over. Above is a record of a strange and amusing meeting that took place in Los Angeles some time ago between a dog and a baby alligator. This provided a real contrast in tails.

W. S. Berridge

GAVIAL AND IGUANA WHOSE TAILS ARE WEAPONS

Besides its long, slender snout the gavial (bottom) has another and better weapon of defence in its tail. This is thick, heavy and capable of extraordinary vigour, and, in addition, is armed throughout its length with dangerous-looking spikes. This long serrated edge, switched rapidly to and fro, is something from which every wise animal beats a hasty retreat. But the gavial, unlike the rest of the crocodile family, rarely attacks land animals, but prefers fish. The tuberculated iguana (top) has a tail like a strong whip.



W. S. Berridge

TAILS USEFUL, USELESS, AND ORNAMENTAL IN THE ANIMAL WORLD

The great islands of Sumatra and Borneo and the Malay Peninsula are the homes of the pig-tailed monkey (bottom left), which has discarded altogether the use of a tail for gripping or prehensile purposes. The famous fat-tailed sheep of Africa (bottom right) uses its tail for economic purposes. When there is plenty of food about the sheep lays up a store of fat in its tail. There is in Africa also a mouse (top left) which does the same thing. By the winter the mouse has covered its whole body and its tail with a thick layer of fat to last it till the spring. The tail of the squirrel (top right) is as graceful to watch as it is useful in keeping balance during the little animal's caperings up and down the tree-trunks.

W. S. Berridge

KING BIRD OF PARADISE AND THE MOTMOT THAT DECORATES ITS TAIL

The king bird of paradise (left) is of small size and wonderful colouring, in which emerald green contrasts with brilliant scarlet. The formation of the tail feathers is extraordinary, the quills being bare almost to the tips, where they coil into a beautifully vaned spiral. The racket-tailed motmot (right) is unique among the birds, for it deliberately alters the appearance of its tail, presumably for decorative purposes. The middle pair of tail feathers are longer than the rest, and the bird nibbles away at them until the quills are quite bare save for a tuft at the ends. The motmots are found in the New World between Mexico and Paraguay. This specimen is from the island of Trinidad.

W S. Herridge

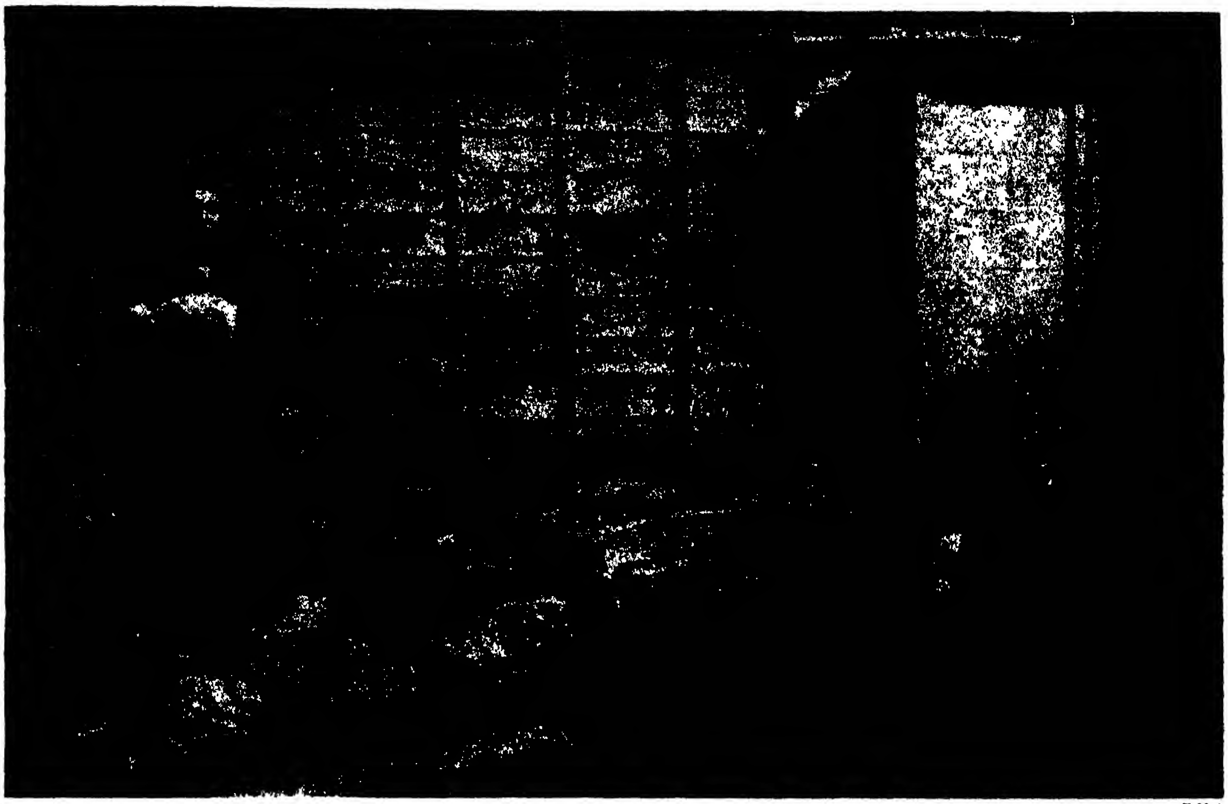
BARE AND HAIRY TAILS OF BEAVER AND ANTEATER

In the beaver (bottom) the tail is particularly conspicuous in that it is flattened laterally and quite bare, whereas the rest of the animal is covered with thick fur. The tail acts as a rudder in swimming. The anteaters all have useful tails, and the great anteater (top) uses its long and fan-like tail for warmth when asleep.

There is another aquatic creature in which the tail is especially adapted to serve as a rudder, namely, that quaint little mammal the water shrew. This smart black and white shrew, which haunts streams and ditches, has a tail about two inches long, with a keel of silvery hairs along its under-surface, so that it forms the neatest and most efficient of little rudders. Quite a different type of rudder is the broad, flattened tail of the beaver, but apparently this serves its purpose just as well, for the beaver is as expert a swimmer as any of the creatures that habitually spend their time in and out of the water.

Advertising tails, such as the dog's, are not uncommon in Nature. That of the rattlesnake is a good example of the tail used for warning purposes. The snake is a dangerous creature, but there is no advantage in the use of its poison when biting some animal it cannot eat. The reptile carries, however, a rattle of horny plates on the end of its tail, and when any person or beast comes near it vibrates this implement, which acts as a warning, letting the world know of the snake's presence and, which is more, that it will be as well to let it alone.

The plume-like tail of the skunk is also a warning one, helping, in conjunction with its owner's conspicuous coloration, to let the world know the animal is coming. Many animals, such as the cat, when angry and frightened, and therefore in a desperate mood, fluff their tails out to double the



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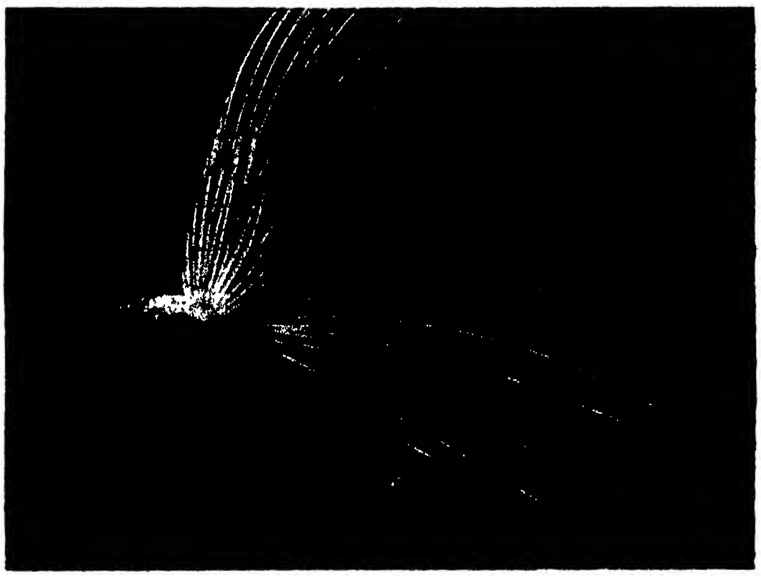


W. S. Berridge

PEACOCK'S REAL TAIL AND A LONG-TAILED COCKEREL

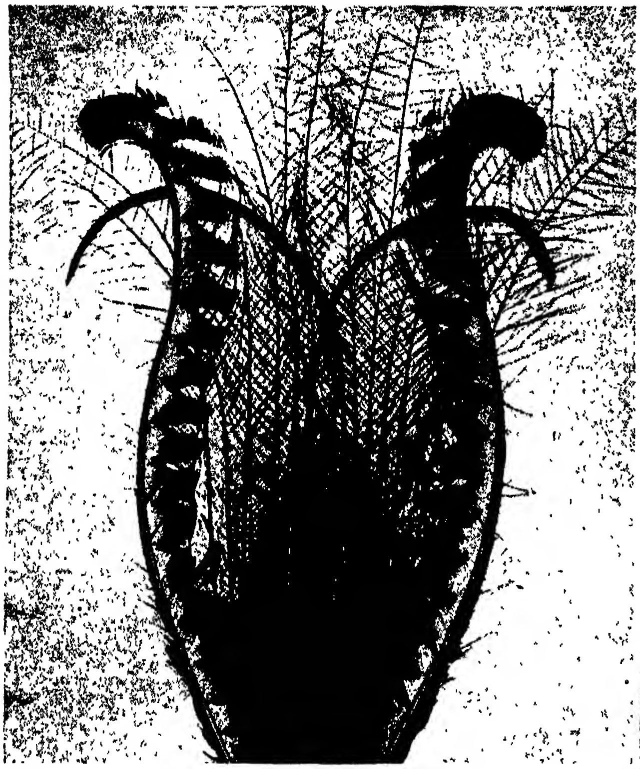
In the lower photograph we see the real tail of the peacock supporting the great fan when it is expanded. This fan is actually formed of the tail coverts enormously enlarged for display purposes. For practical purposes the train is regarded as part of the tail. Above is a Japanese cock with an abnormally long tail.

normal size. This serves the twofold purpose of letting the foe know they really are ready for anything, and bluffing him into thinking they are bigger and more powerful than they are in fact.

In the case of cats, from the domestic puss up to the lordly tiger, the tail affords a valuable clue to the creature's state of mind. The bottle-brush tail, just referred to, indicates anger mixed with fear, but the twitching tail tip of a cat that has heard a mouse squeak in its hole betokens tense excitement. A sideways movement of her tail also indicates annoyance, as when a kitten persists in teasing its mother, and her tail begins to twitch ere she deals her offspring a reproving smack.

Old writers on natural history invariably wrote of the lion as " lashing itself into a fury " with its tail. What they really meant was that when excited its tail was as liable to twitch as is that of a cat.

It is strange, yet nevertheless a fact, that the dog and its kindred also express emotion by means of their tail, but use the same gesture to signify pleasure that the cat uses to exhibit annoyance. A dog, as we all know, wags its tail when pleased and holds it stiff when annoyed, just the contrary to what the cat does. Reverting to tails that are of undoubted use to their owners, the lovely plume-like tails of the different squirrels are for balancing purposes. Take the European red squirrel as it dashes along its



caudal appendage, leaving only a ridiculous bit of a tail that makes but a shabby contrast to the handsome tails of other cats. As long tails seem to be advantageous to the majority of the carnivora, it may be that the diminutive tail of the lynx is an accident of evolution; some cause of which we have no idea has brought about the reduction of the tail, and this big cat has gone on prospering in spite of the absence of a tail, not because of it.

In some cases, however, the absence of a tail is clearly an advantage, those strange water birds the grebes and divers being good examples. These birds, most expert of aquatic species, are marvellously specialised for life in the water. Their legs are so near the extremity of the body as to be perfect propellers (though no good for walking, the divers in particular being as helpless on land as a fish), but these propellers could not do their work as they do if there were a long, feathery tail in the way.

the curious tail of that queer little thing the sea-horse, which is at once its support and its anchor, enabling it to retain its place among the swaying seaweeds. But what of tails that are not obviously important to their owners?

Some of these tails are not quite so unimportant as they look. The rabbit is a good example, for its little white button of a tail is not at all startling; yet when a rabbit flees for home, racing across the meadow with tail bobbing on high, that white button does catch the eye, and there is good reason to believe that it catches the eyes of other rabbits as well, thus acting as a danger signal. Certainly when a rabbit wishes to slip away unviewed by friend or foe, it holds its tail down, so that only the dark upper part is visible, and there is nothing to draw attention to the owner. The deer's white tail serves a similar purpose, for if alarmed by anything it dashes off with its short white tail erect, when the patch of white hair on the rump is exposed, the whole forming a white star that cries "Danger!" to the rest of the deer as emphatically as if the word were shouted aloud.

But what of the tails which not only look unimportant, but really are not of any special utility to the animal? The mole's little stumpy appendage is undoubtedly superfluous, for what good is a tail to a creature that spends its life in a narrow tunnel? None whatever, but that tail is already reduced to the point when it is not in the way. Certain cats, to wit the lynx family, have also bobbed their

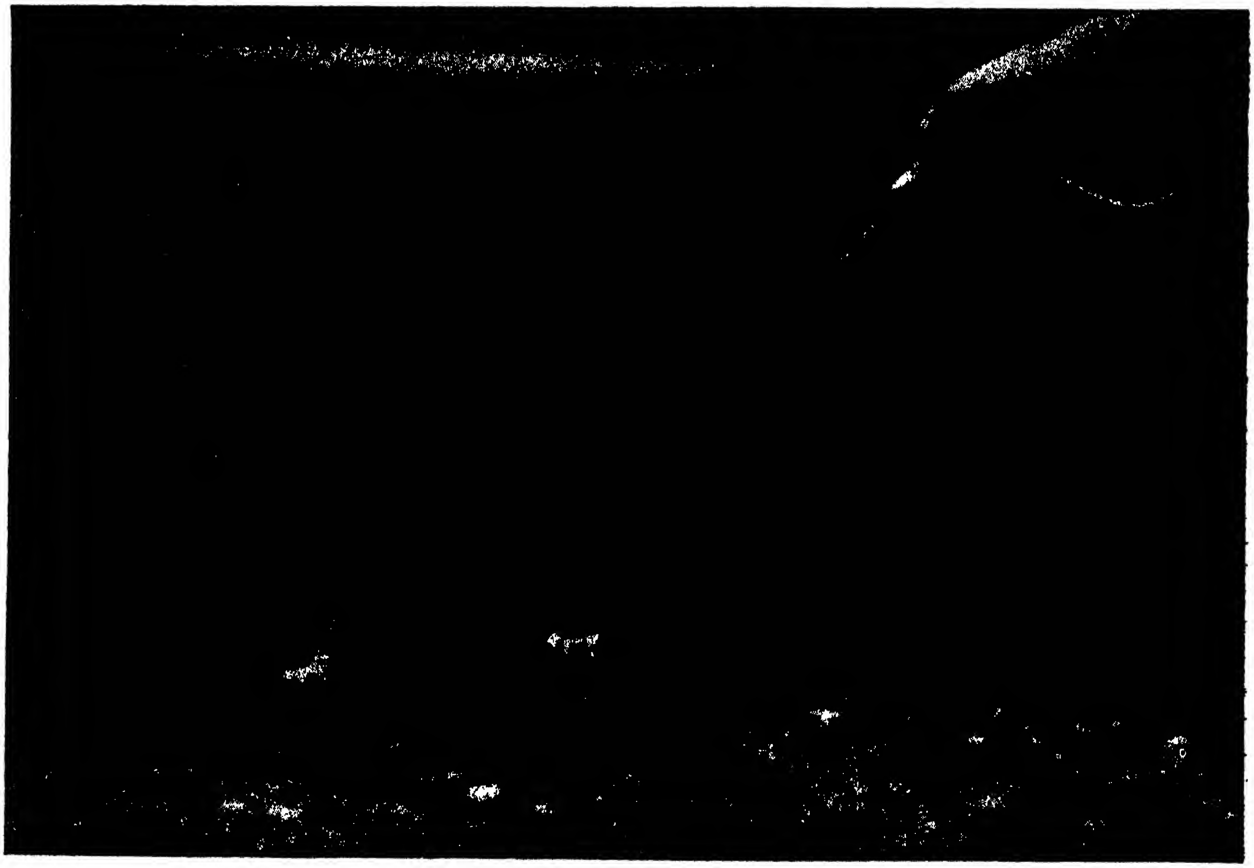
FEATHERED MARVEL OF THE LYRE BIRD

What virtue the lyre bird has expended on its tail it has lost in its wings, for it is a poor flyer. The resemblance of the two outer feathers to the shape of the primitive form of harp is remarkable. The lower illustration is from a drawing.

W. S. Berridge

TREE PORCUPINE AND OPOSSUM WHOSE TAILS MAKE FIFTH LIMBS

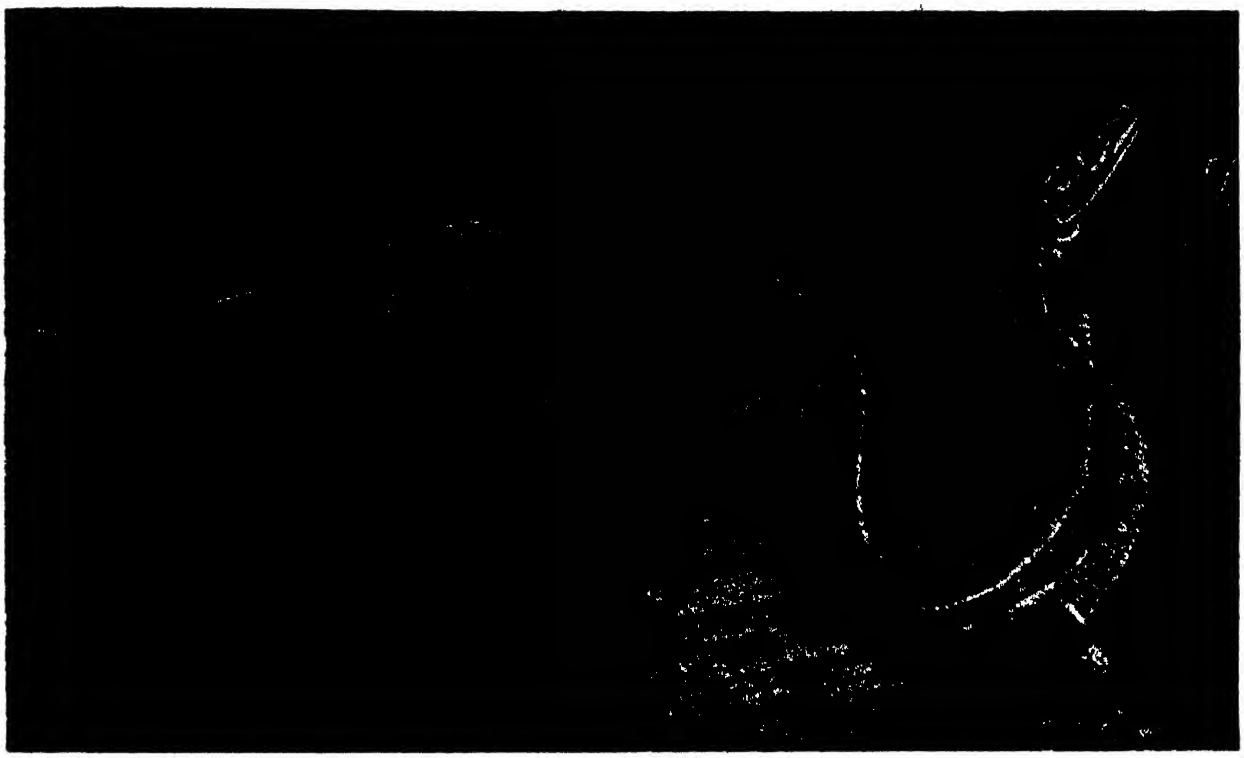
In the forests of tropical South America the tree porcupine is common. It possesses a prehensile tail to help it in its life up in the trees, and thus, if necessary, it can employ all its legs for other purposes, secure in its grip with its "fifth limb." Unlike the porcupine of the Old World, these American tree porcupines are active during the day. Above is an opossum with its young clinging to its back With all this extra weight the clinging tail, coiled like a tendril round the branch, is of great importance



Neville Kingston

TAILS OF THE GAMBIA GIANT RAT AND THE KINKAJOU

Rats put their tails to a unique use when, for the purpose of carrying an egg too large to be held in the jaws, one animal will lie on its back while others pull it along by its tail. In this way the rat makes itself into a kind of trolley. The Gambia giant rat (bottom) has a tail in keeping with its immense size. It is restricted to one part of Africa: the Gambia territory. The tail of the kinkajou (top) is the sturdiest part of the animal, and is about equal in length to the head and body.



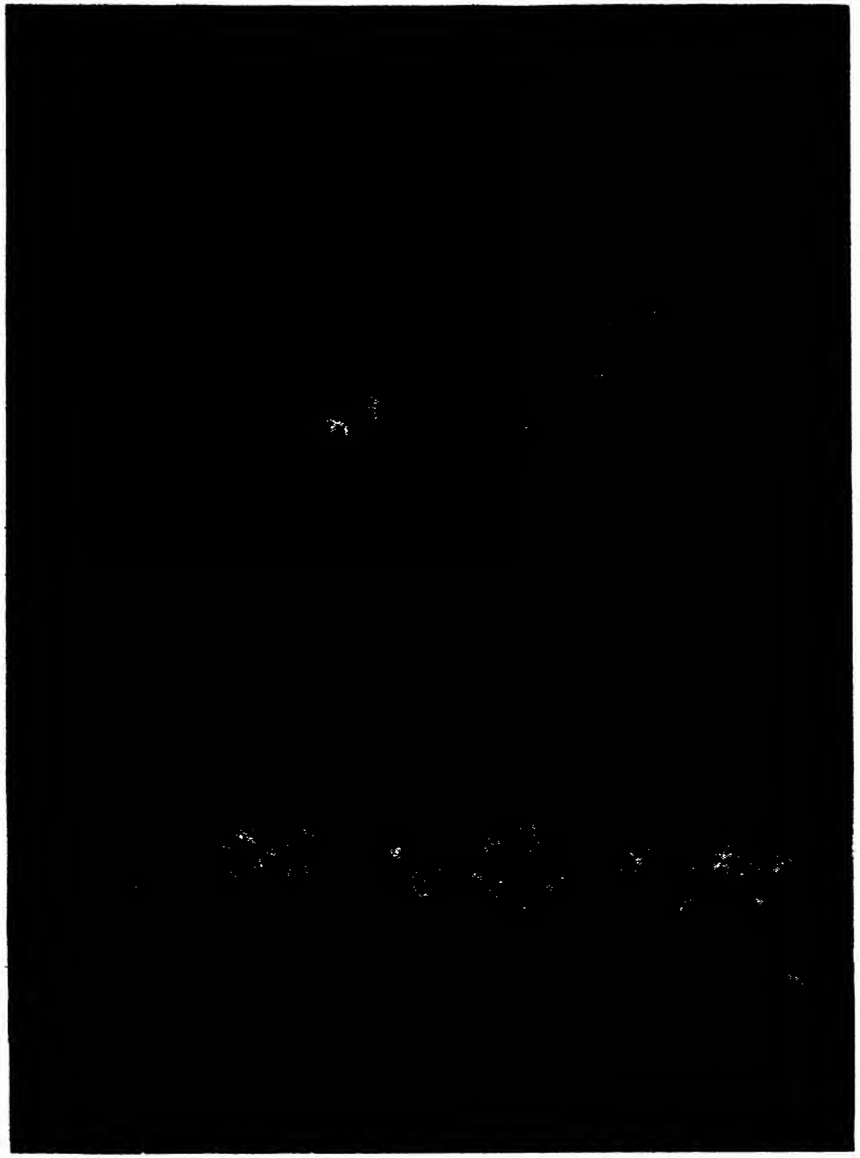
M. H. Crawford

W. S. Berridge

HOW BODY MERGES INTO TAIL IN THE GREEN AND SCALE-FOOT LIZARDS

The body of the green lizard of the Channel Islands (top) merges insensibly into its tail so that, for the total length of the creature its fore and hind limbs seem to be set very far forward. In the scale-foot lizards of Australia and Papua the tail is twice as long as the head and body together (bottom). In this species it is even harder to see where body ends and tail begins, for the hind limbs are so rudimentary as to form mere scaly flaps hardly suggesting legs at all.

The very fact that there are bobbed-tailed birds and beasts, and animals without any external vestige of a tail, including many of the apes, does but emphasise the prevalence of the tail throughout animal life, and draws attention to its widespread importance. The uses to which the tail has been converted, its extraordinary developments, have been but hinted at in this article. It would take a volume, or rather many volumes, to tell of all the tails of the animal world, to say nothing of the tails of past ages, when the prehistoric monsters walked the globe dragging their great scaly appendages behind them.



REMARKABLE WARRIOR AND PARASOL ANTS THAT LIVE IN BRITISH GUIANA

South America is the home of some of the most formidable ants in the world. The warrior ants (left) go about in battalions a hundred thousand strong, carrying their eggs and young ones with them. As they go their presence is often announced by the noise of the ant thrushes, birds which follow the army for the sake of the pickings. Insects form the bulk of the warriors' food, and if an army should visit human dwellings it will make a complete clearance of all vermin, spiders, and so on, without harming human food stuffs at all. The parasol or leaf-cutting ants (right) have a nest below the ground to which they carry sections of leaves. These are laid down to form a kind of bed upon which a special fungus is grown—an instance of ant "agriculture."

Chapter L.

The Amazing Life of an Ant City

By C. K. Ogden

Translator of Forel's "The Social World of the Ants"

Not very long ago a picture appeared in the papers of a strange and complicated invention: a new kind of automatic machine. Hitherto man's inventions have been almost exclusively confined to extensions of his senses, like the telescope, or extensions of his limbs, such as engines and aeroplanes. They have enabled him either to perceive more or to do more; to accomplish, in fact, what he would if he had been endowed with better eyesight, or with more or stronger arms and faster or longer legs. But all have been dependent on the human brain; they did not, like the human organism, stop, reflect, and take some action suitable to changing conditions.

A few years ago, however, the age of Robots dawned. The possibility of doing mechanically what has hitherto been done only by a brain began to exercise the imagination of inventors; and this new device, a sort of chemical Robot for softening water, goes far beyond anything yet achieved. It can make the most elaborate adaptations, and the inventor, Dr. Hatfield, has written a book on the future of mechanical man which recalls the old controversy about the ants.

Have they actually become mechanical Robots and progressed beyond us, so that their present condition indicates a stage which we shall inevitably reach when we have efficiently satisfied all our needs; or have they merely evolved a form of society which we can avoid if we take warning in time? Certain it is that more than a hundred million years before man appeared on the earth the ants, after more than a hundred million years of experiment, had perfected the organization of their social life, had decided in favour of the "specialisation" on the verge of which we are hesitating to-day, and have remained in the same condition throughout historical time.

Our understanding of the wonders of insect life has made great advances of late. The expository gifts of Fabre, the mystical appeal of Maeterlinck, the social wisdom of Wheeler, have all played their part in attracting attention to the crawling, creeping and buzzing universe. But the greatest single influence has undoubtedly been that of Auguste Forel. Forel began his ant studies at the age of five, and the cause of his early interest makes a charming story, worthy even of Victorian England. He tells us how, in a little village on the shores of Lake Geneva, his mother would sit at the piano, playing Beethoven's sonatas, while he, outside on the terrace steps, was watching the ceaseless turmoil of black, red, and yellow ants, cooperating, fighting, transporting. Why did these peaceful and industrious creatures sometimes fight so savagely? That was his first question, and the problem of war and peace remains his chief concern to-day, as it is the chief concern of Geneva, near which he still dwells, the fierce enemy of alcohol in the midst of the vineyards of Yvorne, the ardent apostle of peace in the centre of a war-weary continent.

He began collecting insects alive, and then, since that was regarded as cruel, dead ones. But the mystery of ant enmities grew deeper, till at the age of eleven his grandmother gave him a book by the famous naturalist, Huber. "There," she said, "I will make you a present of this book, written by my old flame Huber. He was not cruel, like you, for he scolded me when I killed the ants that were eating my jam. I have never been able to get through his book. It isn't my style."

SECTION OF AN ANT'S NEST

This illustration from Forel's book shows the complicated gallery system of a nest with its highways and branching byways, with eggs deposited and being attended by the "nurses."

The child found that he had already made discoveries about robber ants which had escaped Huber. But the mysteries were revealed, and he vowed he would devote the rest of his life to the science of entomology; and thus the labours of seventy-five years have gone to make his two wonderful volumes, "The Social World of the Ants." For, in spite of all his other preoccupations, his studies of the insane, his investigations of the brain, and the researches embodied in his most popular work, "The Sexual Question," the ants have remained his dominating interest; and to-day, though paralysed and unable to afford a secretary, he is besieged by requests from all over the world for information which he alone could, yet is unable to, give.

Fortunately, his masterpiece is now available for future

ANT USING POISON SQUIRT

Some of the ants, instead of being armed with a sting, have a poison apparatus at the hinder end of their bodies through which they can squirt formic acid over an enemy, often causing death. This illustration is from Forel's "The Social World of the Ants" (Putnam).

inquirers, and, apart from its value as an introduction to the sympathetic and inspiring personality of the author, it provides the best guide to the amazing life of the ant city in English. And we need a guide not only in order to avoid misinterpreting what we see, as nearly everything about the ants has usually been misinterpreted, but in order to see anything at all. For the ant nest is one of the most difficult things in the world to study under natural conditions, and only the most skilled observers can profit by the opportunities of the artificial constructions in which ants are usually kept. The rest we piece together, often by inference, from discoveries all over the world during the past wonderful century of science.

UPPOSE that, like Gulliver, we could live for a while as minute denizens of an ant city, what would be our most unexpected impression? In the first place, although their work is often carried on in the midst of filth, ants are fastidiously clean both in their persons and as regards the nest, and all refuse is at once deposited in a special dump or midden outside. Perhaps, therefore, we should be most surprised at the amount of time spent by the ant on her toilet; sometimes, cat-like, attending to the face, sometimes licking and polishing either her own shining armour (chitin) or that of her companions. But more probably the methods by which food in various stages of digestion circulates through the community would fill us with astonishment, if not with disgust.

Not only do ants derive intense satisfaction from the liquid exuded by their offspring, but in their own crops or "social stomachs" they carry a variety of viands ready for regurgitation to other ants or to guests. These latter are so numerous and ingenious that it is surprising an ant ever has anything left for herself. The guest, perched it may be on the back of her head, has only to tickle the host judiciously, and instead of purring, the latter at once most obligingly disgorges a meal.

Yet all the while other small creatures are being reared in stables attached to the nest. These are the ant-cattle, kept to suck plant juices, to which the jaws of the ant, as a biting apparatus, have no direct access; and they are tended with the same care as is bestowed on mushroom-growing or harvesting by species which keep gardens or fill their granaries against an evil day. One peculiar method of storing food is that by which "nurses" swollen to enormous size, are suspended like bottles from the ceiling of the nest, and tapped, as occasion demands, for honey.

It is chiefly for food, of course, that the ceaseless warfare of the ants is waged, though their pugnacity is closely related to other activities, which the gentler entomologists deplore. Some kinds are slavers on a large scale, and their slave-raids are as bold and efficient as the Gold Coast ever knew. It has been maintained that the slaves of the ants should more properly be regarded as auxiliaries, since they are quite unconscious of their lot, and have never experienced any happier

the same was true of many children born to negroes in America, and none the less slaves. Young ants are captured and tamed to live in enemy nests, whose odour they then acquire, proving that instincts are capable of considerable modification, at any rate in some species; though the stupidity of the harvesting ants, whose foresight excited the enthusiasm of Solomon, and their failure to adapt themselves to combined work, have impressed many keen and interested observers.

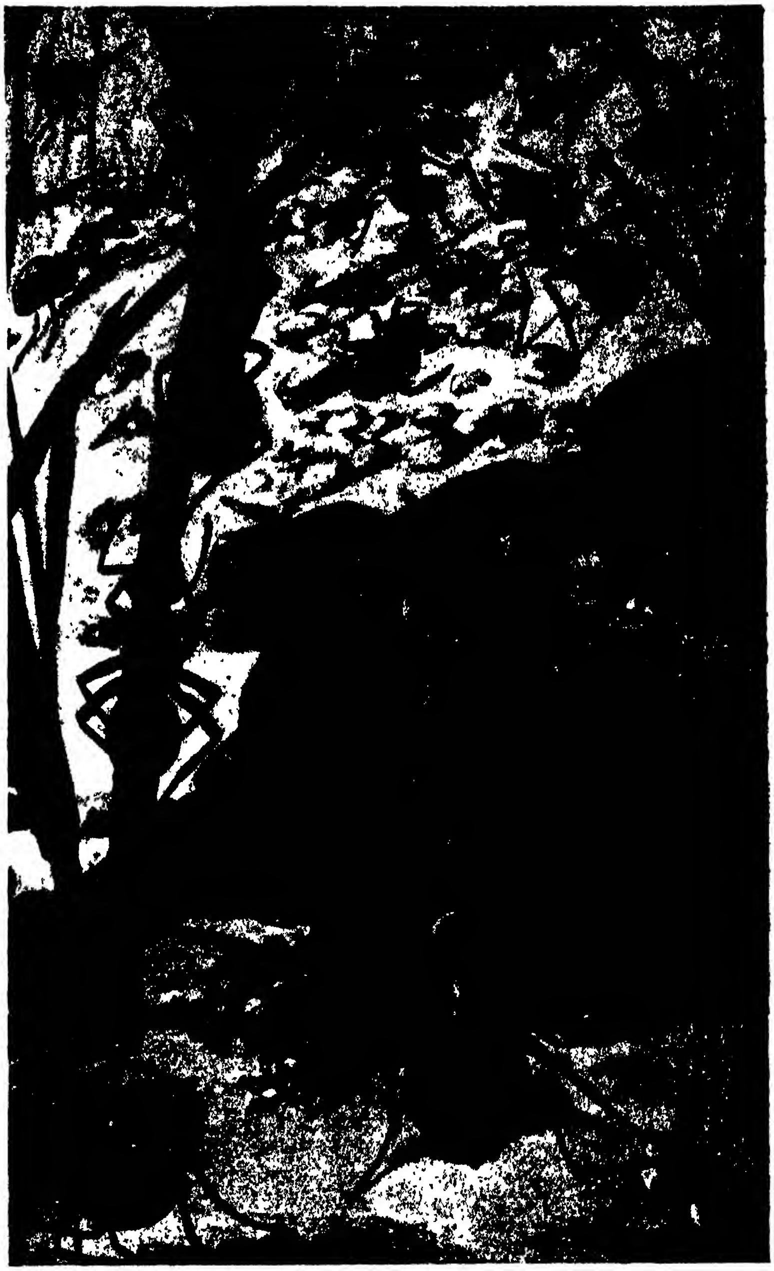
It was long supposed that Solomon had allowed his moral fancy to run riot; for ants in northern countries, where most scientists carried out their researches previous to 1870, go to sleep in the winter, and it was supposed that harvest granaries were everywhere out of the question. But it is now known that Solomon was correct, and it is for the dry, hot season that they "prepare their meat in the summer."

Groceries, then, are no less prominent a feature of ant life than of our own, and it is probably to differences in diet, whether as regards time or quantity, that we must attribute those differences in form and sex on which ant-specialism depends. Apart from the act of fertilisation, however, the male ant plays a very small part in the life of the nest. The workers are all neuter females, whether they function as soldiers or in some civil capacity; but the fertile female, or queen, will retain the male element in a special receptacle for years, using it as she requires.

The actual nuptials, the marriage flights, and the swarms which sometimes darken the August sky, have not awakened the enthusiasm of poets like the pursuit of the virgin queen by her admirers among the bees. Forel quotes Maeterlinck's account of the aerial scene, as the queen bee rises through the blue air of the morning. Drunk with her wings she seeks the heights:

"To some lonely region must she soar unhaunted by birds that might profane the mystery. Still upward she climbs, and now the ill-matched crowd beneath her dwindles and scatters. The weak, the infirm, the aged, the unwelcome, the starveling brood of sluggish or impoverished cities, all renounce the pursuit and disappear in the void. All that remains is a small and tireless group hung in infinite opal. She exacts of her wings one supreme effort, and lo! the elect of the incomprehensible forces reaches her side, seizes her, conquers her; and borne aloft by their two-fold impetus, the ascending spiral of their intertwined flight spins for one second in the hostile delirium of love."

The ants, too, perform their nuptials in the air; but as they are polyandrous and not monogamous like those of the queen bee, they have not yet inspired their poet. Entomologists, with the notable exception of Miss Adèle Fielde, whose brilliant researches were



WAR BETWEEN RIVALS OF THE SAME SPECIES

Ants fight furiously not only with other species, but with rival colonies of their own kind. Here is a fight in full swing between two armies of *Formica pratensis*. Separate duels are going on over stones, up the tall grass stems, and in all sorts of attitudes. This drawing comes from "The Social World of the Ants," by Forel (Putnam).

FIERCE BATTLE BETWEEN GIANTS AND DWARFS OF THE ANT WORLD

Wars in the ant world are caused by territorial infringement. One colony will covet the part of a field used by another colony or perhaps a tree which has a supply of the little aphides which supply the ants with a kind of nectar. Above is an illustration from Forel's "The Social World of the Ants," depicting a strange fight between giant and dwarf ants. The dwarfs are trying to overwhelm their adversaries by crawling up their legs and antennæ, seeking vital spots, while the giants are crunching the little foes with their powerful jaws.

responsible for most of what we know about the sense of smell in ants, are mostly males, and regard polyandry as prosaic. Maeterlinck, however, has lately given us a graphic picture of the swarming of the white ants or termites, the hereditary enemies of the ants; and the tragedy of the male ant, whose fate it is to crawl about till death overtakes him after his descent from those dizzy heights, while the queen carries on the life of the race and founds a new city, is no less worthy of a poet's pen.

THOUGH many of them are now vegetarian, ants are, for the most part, carnivorous, and a difference of smell is all that is required to provoke a fight. Their battles will go on for days, the vanquished being torn in pieces, their stores seized, their brood devoured. The courage and pertinacity of victors and vanquished alike have been admired by the bellicose throughout the ages; their stings, their poison squirts, the mandibles with which they bite, their agility, and their rescue work are proverbial. Nor must we forget their ceaseless warfare with nature and with other creatures, particularly the ant-lions and scaly ant-eaters. Indeed, Forel has found several species of ants, hitherto unknown, in the stomachs of their enemies. One of these (as one might call a baby found alive in a whale "Jonah") he christened "esta," which means "eaten"; and by that name it will be known to science probably as long as our present system of nomenclature lasts.

It is a relief to think that though ants "can certainly feel pain," their suffering must be infinitely less than ours; for they will greedily eat honey a few moments after their abdomens have been severed. How they feel pain—with what nerves—we do not know. Can they hear? We have no definite evidence. Smell? "They are able to recall smells as round, square, elongated, hard, soft and so on, and as having a certain height and being in a certain direction." When we perceive odours, on the other hand, they come as a disorderly medley to the back of the nose, giving us no clear image either of time or of space. We have largely lost our sense of smell, and only by a study of creatures like dogs and ants can we realize how vast is the extent of the possible worlds which we are condemned to ignore.

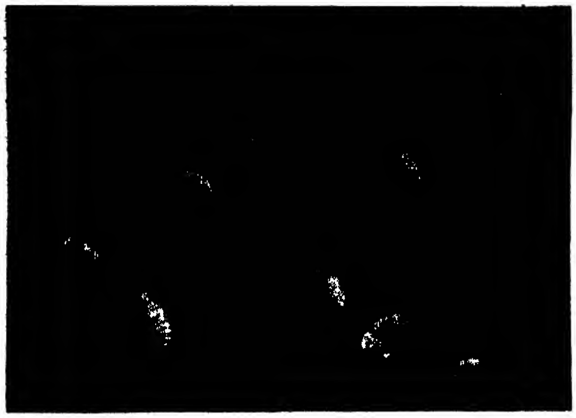
Take the case of sight. We are so accustomed to staring at things in front of us with just two eyes that we forget how many other ways of seeing there are, and how many creatures get along without seeing at all, in our sense of the word.

Ants, for example, though they dwell most of their lives in the warm darkness of the nest, have two kinds of eyes; but in order to see, or rather to

Rev. S. N. Sedgwick

ANT CITY AND PART OF ITS INTERIOR REVEALED

From the outside the nest of a community of wood ants seems to be just a rough pile of pine needles or twigs, although the [illegible] of that pile are surprising when the size of the builders is considered. But when part of the ant city is removed with care (bottom) an intricate system of galleries is revealed. There are places for the larvae and the cocoons, and some of the unl[illegible]t, and, to the ant, vast chambers and thoroughfares of the city go far into the ground beneath the apparently simple and artless superstructure.



any part of the body. They could even read newspapers with their chests.

M. Romains, however, is known as a poet, a dramatist, a satirist, and a wit; and people suspected a hoax. But he was in earnest, and a serious controversy arose, a bitter war of words with the professors. In due course he persuaded Anatole France that he could prove his case. After translating his book into English, under the title "Eyeless Sight," I found that Professor Forel had also been greatly interested, and though, as he remarks, the interpretation of the experiments is contrary to all our present ideas, he is prepared to consider the claim seriously. As a result of his life-long study of the eyes and brains of ants and men, he had even gone so far as to experiment with blind people before he knew that others were already engaged in work of the same nature. At the moment the controversy is still in progress. A blind American lady who went to Paris to practise "eyeless sight" has written a book stating that she succeeded; but this is more than doubtful, and the matter remains a tantalizing speculation. The great majority of scientists regard the objections as at present insuperable.

S. N. Sedgwick

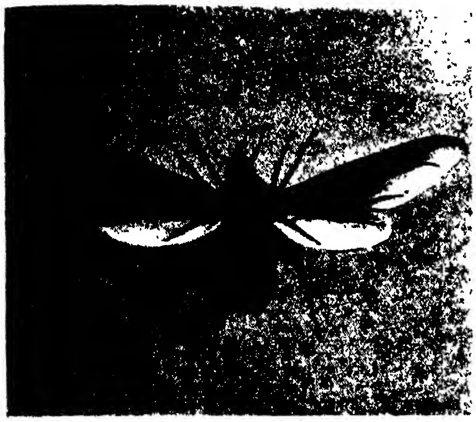
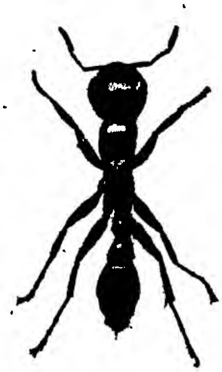
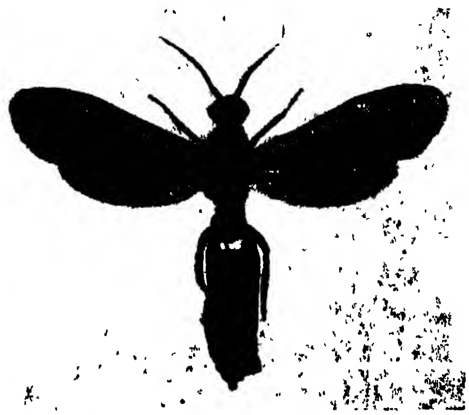
ROYAL FAMILY AND ATTENDANTS: AN ANT "STABLE"

In the lower photograph we see the princes and princesses of an ant city just emerged from their cocoons with the help of the nurses. These nurses accompany their charges to the outside of the nest whence the males and females will soar into the sunlight for the nuptial dance. Above is a "stable" for the aphides or green-fly.

perceive, they combine sight, touch, smell, heat and so on in ways which at present we can only dimly realize. Very soon it will be possible to make a film magnifying ants to the size of men, so that we can see all parts of their bodies a thousand or even a million times as large as we do at present. If a man the size of St. Paul's could be observed by a physiologist, a lot might be discovered about parts of the skin, the eye, or the brain which is at present a complete mystery. By studying the ant similarly enlarged, we might discover facts about its behaviour which would be of great service to those suffering from blindness.

But there is another interesting thing about sight. The eyes of the ant are, for the most part, constructed like those of the dragon-fly or the butterfly out of thousands of tiny facets. The dragon-fly has over twelve thousand such facets, and this fully explains its skill in poising itself at the precise distance which is beyond the reach of a hand or a net. Such eyes are sensitive chiefly to moving objects, for ants cannot rest the retina by blinking as we do, and anything stationary is, therefore, visible to them only for a very brief moment. That is why their behaviour may repay more careful study, for, after all, our eyes are only a special part of the skin which has gradually come to be used for the function of sight. In some creatures the skin is sensitive to light; they actually see with their skin. And this fact suggested to a French writer, Jules Romains, that our skin, too, might still have some of its original powers if only we could learn to revive them. So he set to work to experiment with Eastern methods of concentration to make use of some of that mental control which enables certain people to alter the rate of the pulse, to blush, or to twitch muscles at will. Eventually he claimed to have taught blind people to see with the skin, and to have trained friends to see with almost

THERE is, however, another speculation which is more promising. The most important sense organs of ants are their antennae which, like a cat's whiskers, tell them a great deal about the outside world. How do ants communicate with one another? They tap out messages in various ways with their antennae. The Jesuit Father Wasmann and Forel are in agreement on this point, if on nothing else,

ANTS THAT HAUNT THE FORESTS OF TROPICAL AMERICA

On the left of this trio we have the celebrated sauba or parasol ant of tropical America which cuts sections of leaves, stores these in the nest until they ferment and rot, and then, on the leaf mould so formed grows mushrooms for food. In the centre is the acana ant from the Amazon valley and, on the right, a winged foraging ant which belongs to a fierce, predatory species whose members make no settled abode, but wander in their thousands, raiding other nests. The ants in these photographs are shown magnified.

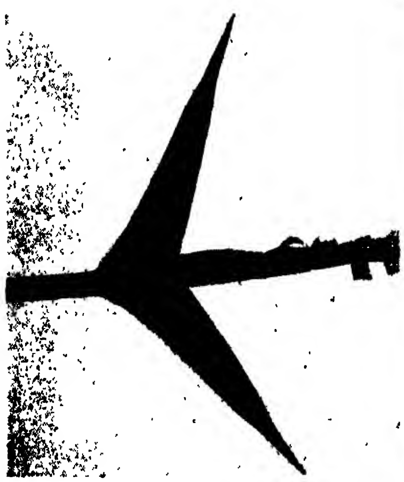
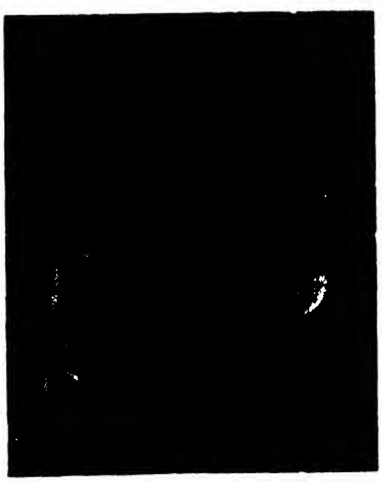
and no one will accuse the former of going out of his way to make ants resemble human beings.

This tapping code is used in eight different circumstances; as a signal for collective work, passed from one to another; to secure honey-dew; to indicate the direction of a trek; to give information about a source of food; to incite to attack or flight; to warn of danger from some special quarter; to calm a case of nerves; to initiate a slave-raid.

Here again the possibilities of an ant film are suggested. With ants the size of a man, every movement of the antennae could be closely observed, and repeated at will, like semaphore signals which we fail at first to understand. The behaviour of all concerned before and after the incident could be minutely examined in the light of what we have already discovered concerning bees, beetles and cicadas, all of which make known their doings in surprising ways. Any sounds caused by the tapping could be amplified by the same methods which have enabled a heartbeat to resound like thunder. Perhaps Dr. J. G. Myers, whose studies of the cicada's songs have been so successful, will one day help us here. But the solution will probably come from the tropics, where ants are larger, more numerous and, presumably, noisier.

Of the architectural and engineering feats of the ants it is impossible to speak without elaborate diagrams, but the nicety with which they judge distances and stresses and the speed with which they inspect works begun by their companions, in order to co-operate or correct errors, present some uncanny problems for the student of instinct.

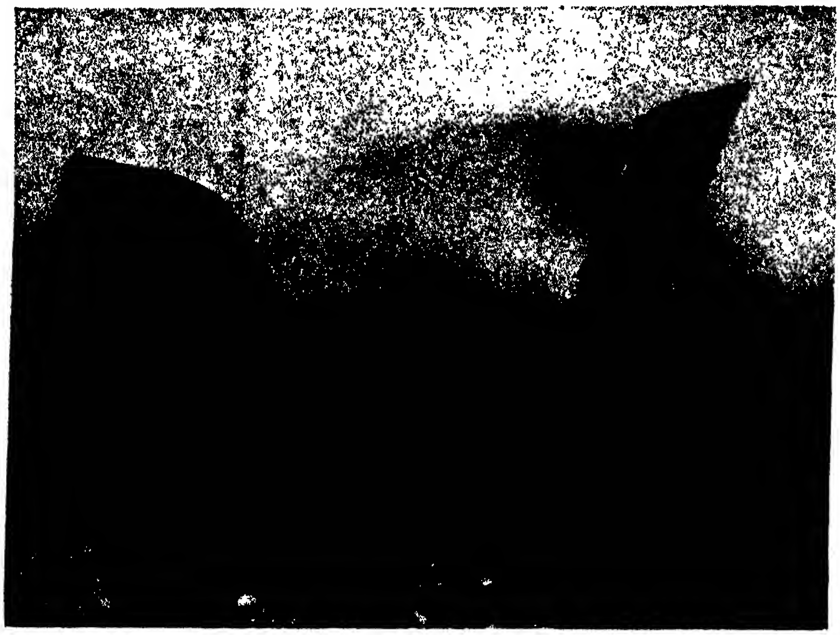
The same is true of the accuracy with which they judge direction outside the nest, for there seems no


H. Bastin

ANTS THAT GO TO PLANTS FOR THEIR MEANS OF LIVELIHOOD

Certain ants who are neighbours of the saubas inhabit acacia bushes. Each ant bites a hole through one of the acacia thorns (left) and eats out the soft core. It then has a fine home and, furthermore, a constant food supply for the acacia exudes a liquid from its leaves (centre) of which the acacia ant is very fond. These leaves also possess special tips containing nourishment for these ants. The right-hand photograph shows an ant trying to reach the flowers of a wood sponge which are inside the leaf.



necessary they work in chains, only the two end members of a chain being actually in contact with the leaves. This use of one living creature by another as a working tool is only paralleled, except amongst humans, by the old fable of the cat's paw.

"Consider her ways, and be wise." We can learn what to do, but we can also be wise in time. Those who have devoted most thought to the foibles of ants and men see in our Universities, for example, one of the chief mechanisms by which we stifle the originality and vitality that might save us from becoming ant-equated, if the term be permitted. Here is the verdict of Professor Wheeler, on whom Forel relies for much of his American material:

doubt that they are often guided by the sun; and it has lately been suggested that the moon and even the stars may play a part. Anyone who has disturbed an ant track must have marvelled at the speed with which the procession was resumed, and in some cases the ant army moves for considerable distances. Migrating species change their abode every few weeks, and the expedients they adopt to overcome obstacles include the formation of their army into a solid ball which can be carried over water.

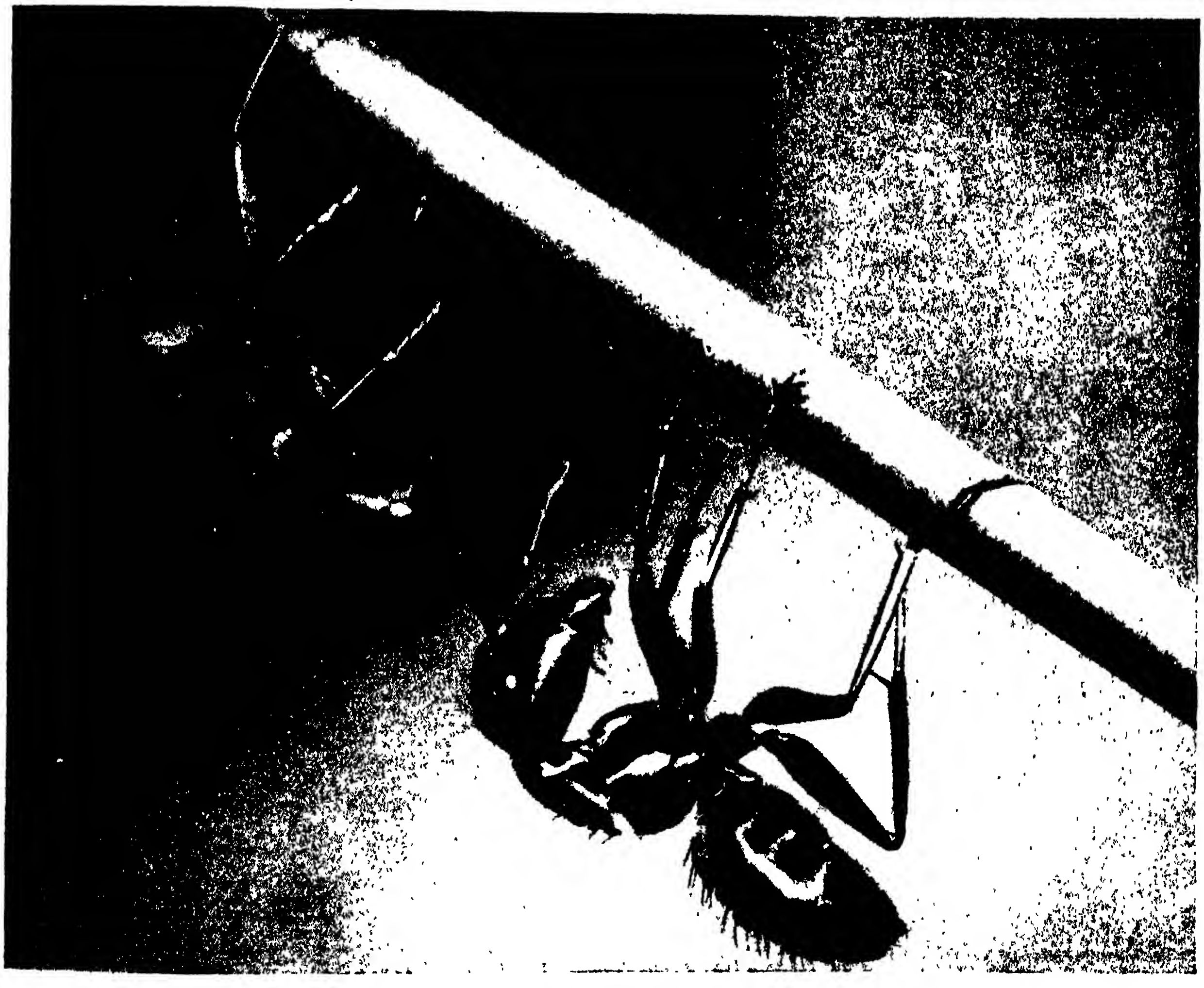
LEAF CUTTING ANTS AT THEIR WORK

In obtaining the pieces of leaf from their fungus beds the sauba ants display most workmanlike methods. The lower photograph illustrates how the leaf section is raised into a convenient position. This is an excellent example of ant cooperation. Above is a pair of ants returning with their loads Photographs by P. G Howes, of the Bruce Museum, Greenwich, Conn.

The leaf-cutters of South America, as they return from their labours each with a leaf many times larger than itself, have all the appearance of a vast procession protected by sunshades, and for this reason they are often described as "parasol" ants.

Perhaps the most curious of the industrial habits of the ants are those connected with weaving. In order to produce the finely woven silk of which their nests are composed, certain Indian ants use their own larvae as a weaver uses his shuttle. A whole squad will set out, each carrying a larva to a place between two leaves, and fix their mouths to the edge of one leaf, while another squad pull the leaves closer and closer together. If

To us gerontic schoolmarms in trousers, who have flown from reality and have slowly succumbed to autistic thinking, with defective eyesight, doughy musculature, brittle ossifications, demoralized intestines . . . and atrophied interstitials, there comes every year a small army of freshmen very properly so called—in the late teens and early



CARPENTER ANTS RESTING AND WARRIOR ANTS ON THE MARCH

Even the ants rest sometimes. The carpenter ants (bottom) are quite at ease hanging upside down in this fashion. They make their home in the solid timber and carve long galleries in it. The warrior ants (top) carry their eggs and larvae with them and are thus independent of any headquarters, while they subsist by attacking the strongholds of other species and eating the garrisons. These photographs are much enlarged to show detail and were taken by P. G. Howes, of the Bruce Museum, Greenwich, Conn.

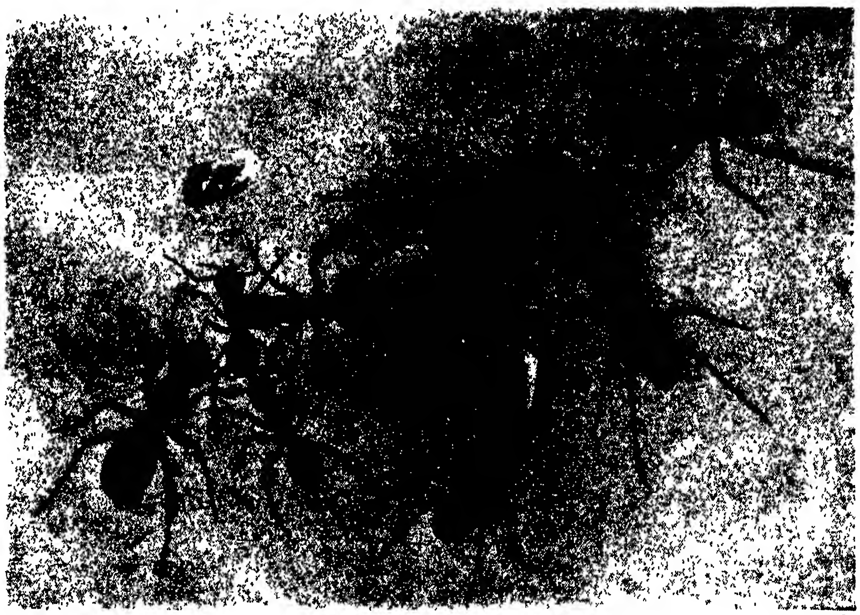
ment, to the elaborate toilets already mentioned, or to snoozing quietly until they are roughly awakened by taps of the antennae to new industry or new conquests.

Have they any sluggards, dissentients, contemplators? We do not know. But at least they have no scruples about sacrificing the inefficient. With such a population problem the possibilities of humanitarianism are small, for ant figures are as staggering as those of the astronomer. There are over five thousand distinct species of ants, which cannot interbreed any more than tigers and rabbits among animals; but there are probably ten thousand different kinds—as different as English and Chinese. No

twenties, burning for impact with reality, with exquisite sense-organs, superb bones, muscles and alimentary tracts . . . and what do we give them?"

The same writer, in discussing the alarming inroads of "organization," and its effects on research, has contrasted the few means of escape from schedule and routine still available for the human mind with the complete "efficiency' attained by the ant. He suggests that:

As the earth becomes more densely covered with its human populations, it becomes increasingly necessary to retain portions of it in a wild state, free from the organizing mania of man, as national and city parks or reservations to which we can escape during our holidays from the administrators, organizers and efficiency experts and everything they stand for, and return to a Nature that really understands the business of organization. Why may we not regard scientific research, artistic creation, religious contemplation and philosophic speculation as the corresponding reservations of the mind, great world-parks to which man must resort to escape from the deadening, over-specializing routine of his habits, moods and occupations and enjoy veritable creative holidays of the spirit?



H. Bastin

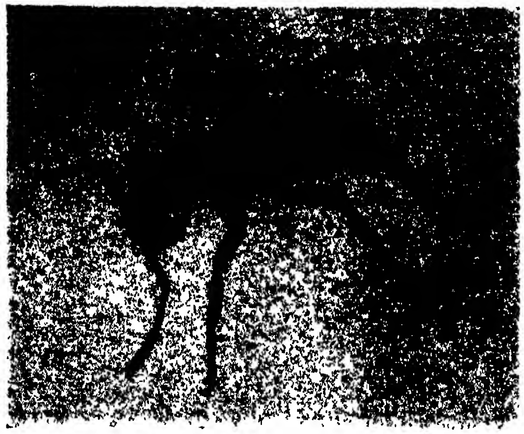
SLAVE RAID AND FUNERAL PROCESSION IN THE ANT KINGDOM

Here (bottom) is a slave raid in progress, the larger ants making away with the cocoons of the smaller. The ants which hatch out of these cocoons will be trained in the service of their masters. When ants die the corpses may be removed from the nest or buried in a special part. Above some black ants are taking the body of a queen which has died outside back to the nest.

We have seen that even the ants find time to play, though we may suspect that their play is designed to lead to greater efficiency. There are signs, too, that on occasion they give themselves over to enjoy-

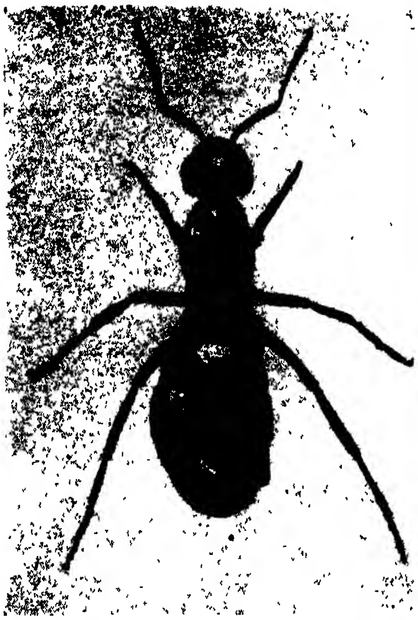
wonder entomology has become one of the most specialised and exacting forms of science, for to the ordinary eye most of these ten thousand are as much alike as a flock of sheep.

Whoever tries to deal with the ant statistically will have no easy task, for, though no ant is so prolific as the termite queen, which is capable of producing over a hundred million children, there may be



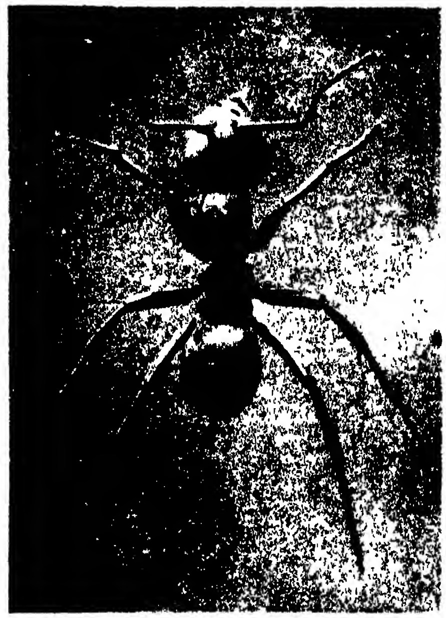
Worker

Larvae



Queen

Cocoons



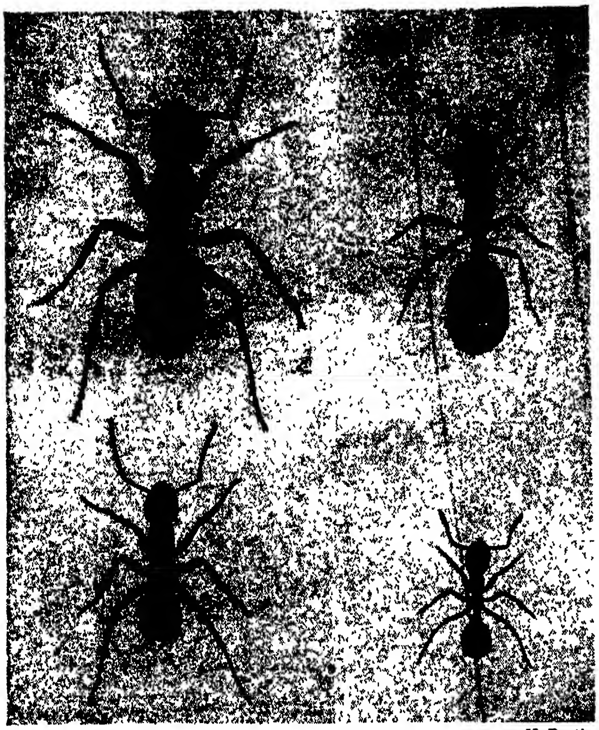
Worker

Winged Male

Winged Princess

INDIVIDUALS IN THE DRAMA OF THE ANT CITY

At the head of the ant community is the royal family, consisting of the princes (bottom, left) and princesses (bottom, right). When the mating flight is over, the princesses lose their wings and settle down to carry on the race, while the princes die sooner or later. The workers, sterile females, do the labour of the city. The familiar "ants' eggs" are really the cocoons spun by the ant larvae. Out of these cocoons the emerging ants have to be helped by the attendant nurse workers. These photographs of wood ants are by H. Bastin.



H Bastin

SLAVER AND HOUSE ANTS

On the left is one of the slaver ants with the smaller species which it breeds as its servant. On the right we see a queen and a worker of the house ants, a species which appears to be tropical in origin and which cannot live in the open.

more than the total human population of the globe in a single settlement. Thus, unlike ourselves, their younger generations cannot complain of any lack of opportunities for promotion.

It was Goethe who first diagnosed the tendency which threatens us with the stagnation of the ants, when he made the cruel remark that the funerals of public men do not succeed one another with sufficient frequency. Professor Wheeler has even offered to draw up "a list of fifty well-meaning superannuated reactionaries who, within recent years, have done more harm to civilization than any equal number of criminals one might select." Forel is not so harsh, for he believes that if we could abolish wars between nations (and, be it always understood, find harmless means of slaking our thirst) we should have plenty of incentives to further effort and perfectly adequate resources to realize our ideals. That on occasion may, each of us may draw his own moral, according to his political convictions, his religious traditions or his personal predilections. Forel, himself a radical and a visionary, admires the communistic institutions of his little friends, tries to defend them against the charge of militarism, and urges us to imitate their virtuous, orderly, and self-disciplined habits before it is too late; before alcohol has enfeebled our overworked brains, or before the next war shall put back the clock still further towards the Dark Ages! We are to set to work to build up a "supernational human formicary," a world-organization which the ants have never imagined and because of their size can probably never achieve, though they have blindly taken so many steps on the road we seem bound to travel.

As Forel says:—"One human formicary, united throughout the world, and at the same time divided into a host of multi-cellular individuals, townships, nationalities and States superimposed upon one another, but supple in their restricted liberties, will replace the barbaric conditions of our ancestors and all their warlike anarchies. It will free humanity from a great deal of distress, without, however, realizing the Utopian ideals of certain visionaries for a quickly-approaching earthly paradise in which all men suddenly become angels. No—we shall always have need, alas, of laws, tribunals and police, even prisons and madhouses, by reason of the pitiless heredity of our innate feelings. But all these things must be completely reformed. Many lunatic asylums have already set us good examples in this respect. We may hope that the eugenics of the future, if well applied, will even be able to improve by small degrees the quality of our higher races."

WINGED ANT AND A WORKER

Among the ants it is only the males or princes and the princesses who are equipped with wings. These they use in making their nuptial flight, for the mating takes place in the air, never in the nest. Furthermore, when a princess is mated and becomes a queen she loses her wings. The worker (right) never has wings and has no need of them, spending her life in the nest

Chapter LI

Gluttons of the Sea

By Dr. William J. Dakin

Professor of Zoology, Liverpool University

WHEN we hear stories to the effect that the daily fish requirement of a single seal costs as much as would keep a man at the Ritz Hotel, that a cormorant can go on swallowing fish as often as they are presented to it, and that there are fish which are six times bigger after they have fed than they were before their meal, we are naturally liable to jump to the conclusion that there are some appalling gluttons in the animal world—even if we allow that the stories have been fishermen's tales!

It must be remembered, however, that we regard a glutton as a person who eats excessively and it is very doubtful if the normal appetite of any creature in nature can be termed gluttonous. The portly gentleman who develops what is subtly called a "corporation" is not liable to be chased by an enemy with an axe although he may die of apoplexy in his study. The life of one of nature's "voracious" animals is too much a struggle to permit of excess.

The fact is that every creature requires a certain minimum amount of food to provide it with energy and material for the upkeep of its body. This minimum may in some cases appear extraordinary to us, for there are several causes which may make the food requirements of an animal very large.

In the first place the actual nutriment in quite a large bulk of some particular kind of food may be small or much may be indigestible. An animal would have to eat a lot of this stuff to cover its needs. Again, these needs may be unusually great. Probably no creature eats more in its existence than a silkworm caterpillar, which devours 4,700 times its own initial weight. This is because it must store up nutriment for a long resting period when no food is eaten. A vampire bat has a very short intestine and probably requires very little food, for blood requires little digestion and must be regarded as of high nutrient value. A huge boa-constrictor may swallow a mammal of relatively extraordinary size, but it goes a very long time before its next meal.

It is true that some of the most voracious appetites are exhibited by sea creatures or by animals closely associated with the sea; they are particularly interesting creatures, too, far more exciting than the fat caterpillar steadily munching leaf all day long. Let us begin with the fish.

Most fish are restricted in some way so far as *kind* of diet is concerned, that is, their mouth apparatus, jaws, teeth, and so on, are definitely adapted to one type of food. Thus the sardine, the herring, and hosts of others, feed upon microscopic floating creatures which they filter out of the water by comb-like structures on their gill supports. You might not think that these fish could be gluttons, because if you take up a glass of sea-water you would not see much in the way of microscopic life in it, but hundreds of thousands of tiny organisms have been taken from the stomach of a sardine, and heaven only knows how many little copepods, each the size of a pin's head, may be found in the stomach of a herring. These fish can evidently filter a large amount of water.

Another type of food restriction can be illustrated by the sharks. We certainly regard them as voracious and also their relatives, the rays. Some rays can only feed upon shell-fish; their teeth are flattened and specially adapted to crushing shells, whilst on the other hand the really

R. W. Stemson

WALRUS, GLUTTON OF THE COLD SEAS

When it is realized that a full-grown male walrus may be as much as twelve feet long and weigh three thousand pounds, the size of the meals necessary to sustain this great mass and the energy required to move it may easily be surmised.

W. S. Berridge

Natural History Museum

ATLANTIC SWALLOWER AND A DOG FISH

Of all the monsters of the sea which are remarkable for their eating the swallower heads the list It has so expansive a stomach, compared with its size, that it can swallow fish larger than itself. The stomach stretches until it is so thin as to become transparent. Above is a dog fish, a species of small shark.

dreaded sharks have rows of sharp teeth perfectly fitted for a hasty snap at a slippery fish and equally horrible as a trap for a human leg. These fellows would find it impossible to eat shellfish. The shellfish eaters are by no means less greedy because of their diet; they can put away huge quantities and have been regarded as one of the causes of the depletion of the pearl oyster fisheries of Ceylon and other oyster beds. The author once watched a shark (of the man-eating species) at very close quarters tearing huge chunks off a floating half-decayed whale. It made it easy to appreciate Melville's description in "Moby Dick." "If you have never seen that sight" (that is, ravenous sharks round a dead whale moored to a whale ship at night-time) "suspend your decision about the propriety of devil-worship, and the expediency of conciliating the devil."

But the palm for fish voracity must be given to the fish which are four or five times bigger after a meal than they were before it, and this because they have swallowed a fish much bigger than themselves. This is not a fisherman's story; it is an actual fact and can be easily verified by a visit to the Natural History Museum in London. They are rarely seen by man for they live in the ocean at depths of from three to six thousand feet—think of having always a mile of heavy water over your head! There is practically no light, and therefore no vegetation. Food is scarce and consequently the most has to be made of it when chance brings it. These "Gastrostomids" from the depths of the Atlantic are practically only great trap-mouths with a stomach and a whip-like tail—when empty. They can, however, extend their stomachs outside their body and so capture and take in fish larger than themselves. They do not hesitate to eat their own kind either!

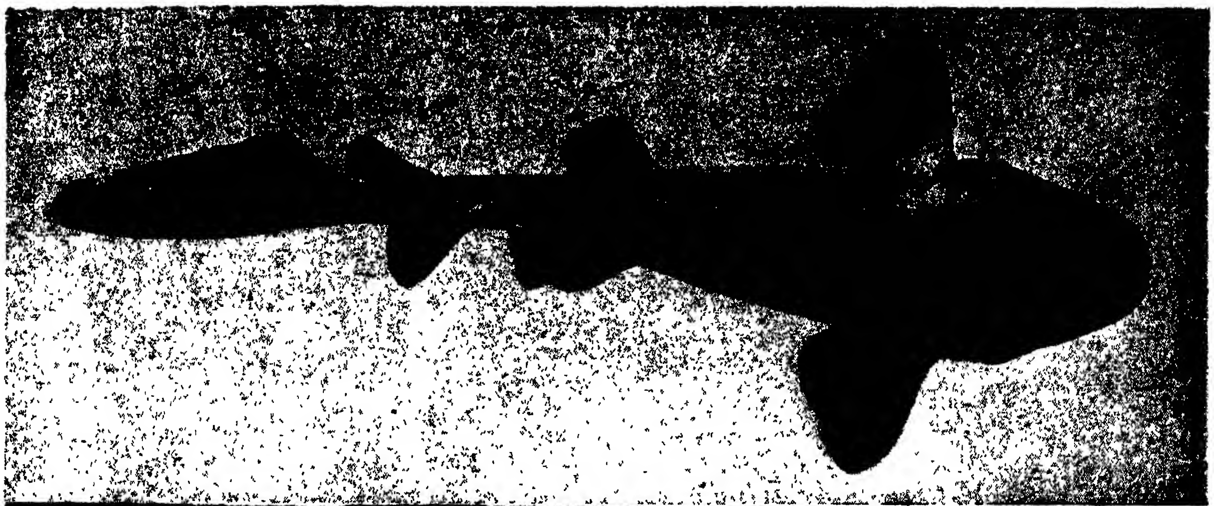
Some fish, including the sharks, seem to take a delight in killing far more than they can eat, perhaps the nearest approach to real gluttony. The teeth of these predaceous fish are slender, very sharp-pointed and adapted for capturing swift and slippery prey. It follows that they are not suitable for chewing food. Possibly also their owners have no time to do so. The prey is disposed of as quickly as possible by swallowing, and it is not surprising therefore that the booty should reach the stomach of the capturer alive. In fact, it is on record that a fish so swallowed has eaten its way out through the stomach wall and actually escaped!

Evidently, amongst the fishes themselves, life is either *Je mange* or *Je suis mangé*, and at times these habits become distinctly annoying to fisher folk. Off the coast of Western Australia the fishermen could not use a common English mode of fishing, that of setting "long lines" with hundreds of baited hooks at intervals. Probably each hook would catch its fish, but these would immediately be removed by useless sharks which might in turn be caught by the hooks. In nearer waters the thresher

Martin Duncan

OCTOPUS AND JOHN DORY THAT GET THEIR MEALS BY STEALTH

With eight strong tentacles, each equipped with many suckers, the octopus (bottom), hidden among the rocks, seizes its prey and conveys it to the mouth. The curious John Dory (top), which is esteemed highly by gourmets, has an enormous mouth and a corresponding capacity for small fish such as sprats. These it obtains not by superior speed, but apparently by keeping end on to the fish it means to devour, when the dory's extraordinary flatness makes it an inconspicuous and unalarming line in the water.



Natural History, N.Y.

NURSE SHARK AND ITS DREADFUL TEETH

Nine rows of teeth in one jaw make for quick eating (bottom) and this is the equipment of the nurse shark. The shark is curious in that although its young are born alive, they are believed to develop in an egg covering, this forming an interesting example of transition between egg laying and bringing forth young alive. The nurse shark swims in American waters.

shark preys upon shoals of herrings, pilchards, and sprats and destroys incredible numbers, swimming round and round a shoal in ever decreasing circles, violently beating with its enormous tail (hence the name, thresher) until its victims are conveniently huddled up together.

The voracity of fish may, however, be even more clearly seen in the restricted waters of rivers and lakes, where numbers are limited and other factors tend to weigh the balance against fish life. For an example, we cannot do better than study the pike of English rivers. He is rather popular, indeed, as a fish except perhaps with those whose trout waters have suffered from his depredations. There is an element of mystery in the pike, whose ferocity is often passed over on account of his tenacity and pluck. He is a true fresh-water fish, found over a wide range in Europe, Asia, and North America. Many stories have been told about both the size and the voracity of the pike For a long time Ireland was looked upon with grave suspicion on account of these tales, but there seems no doubt now that fifty-pound monsters are to be taken occasionally in its waters. Plenty of twenty to thirty pounds weight are to be found.

Not disdainful of a minnow, the pike has been known to attack ducks and even rats, and, of course, every kind of fish. I believe one has been discovered with its head jammed down the throat of another. Naturally, this fish—which, by the way, is very prolific—is not a desirable guest in trout waters. In fact, one small pike in such a spot might do more harm in a season than all the poachers of the district together could do.

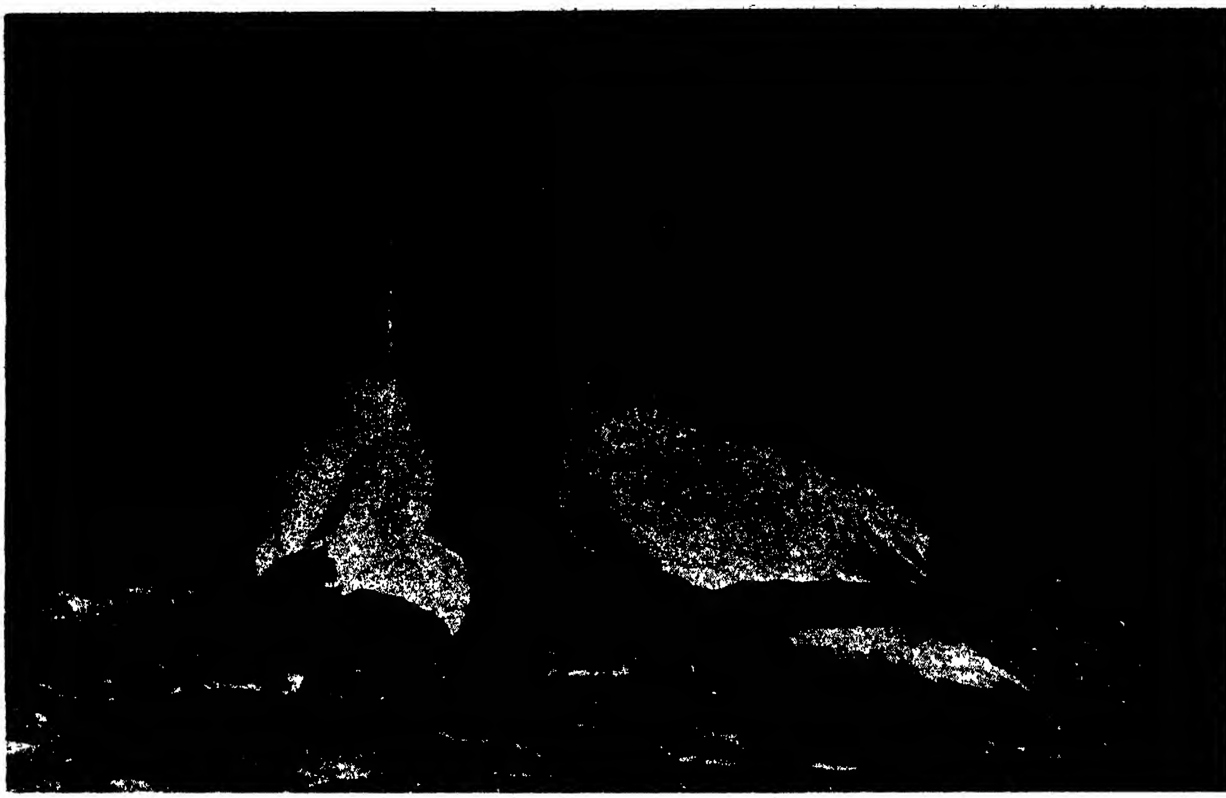
So much for the fish themselves. Let us turn for another example of voracity to the birds who are interested in fish life. The fact that we sometimes impolitely decorate certain undesirable specimens of the human race with the term "old cormorant" at once brings this bird to mind. To realize the full possibilities of the cormorants one has to see these birds where they congregate in their thousands; or, conversely, to see the trained cormorants of the Chinese catching fish with their masters. They used to be employed in England, but for a gentleman's sport. Probably very few of our home gardeners realize that when they use Peruvian guano they are supplying their plants with nitrogen produced as excreta by the cormorants, pelicans, gannets, and boobies of islands in the Pacific. Its ultimate source was therefore the flesh of Pacific Ocean fishes.

The birds in these regions move in flocks like clouds, and it has been estimated that on one small island of less than one square mile area there were

E N.A.

STRANDED GLUTTONS AND SHORE SHARKS IN AN AQUARIUM

At Port au Prince, capital of the republic of Haiti, these sharks (bottom) had the misfortune to be stranded, thus giving an excellent opportunity for studying their size and gauging their feeding capacity. The New York Aquarium often obtains some fine sharks, and those seen here (top) are shore sharks caught off Sandy Hook. They attain a length of six feet or so, and are said never to attack human beings. They are attended, in their tank, by some dog fish—also very voracious in their habits.



GANNETS THAT WORK HAVOC WITH THE HERRINGS

Widely distributed throughout the globe and common on the rockier coasts of the British Isles, the gannet or solan goose is a large bird, three feet long, and in British waters takes great toll of the pilchard and herring shoals. The birds fly along and then suddenly close their wings and fall headlong in the sea—and very seldom dive in vain.

probably ten million cormorants. It would require from four thousand to twenty thousand tons of fish per day to sustain that colony! It seems almost incredible, and yet a cormorant has been known to devour seven pounds of fish per day. That is what it can do in a zoological garden if given the fish. Still more extraordinary is the way the cormorants capture their fish. They leave the surface of the sea where they have been swimming, descend into the water and, using wings as paddles, conduct hunt and capture whilst submerged. Photographs showing this will be found on pages 370 and 371. They return home at sunset, and what a sight it is with lines and lines of birds crossing and re-crossing, and with but very few clashes!

It has been estimated that a single flock of cormorants observed on one of the Peruvian guano islands would consume each year a weight of fish equal to one quarter of the entire catch of the United States fisheries, and this has been going on for ages. The young birds which stay at home feed by thrusting their heads down the parents'

Neville Kingston

throats. This is also the case with the pelicans, which are close relations of the cormorants. There is no doubt about the greediness of the young birds; they swallow the fish whole without even withdrawing their heads from the mouth and gullet of their mothers! In fact, it seems that if it were not for their wings, the young might disappear altogether down into the depths of the parent.

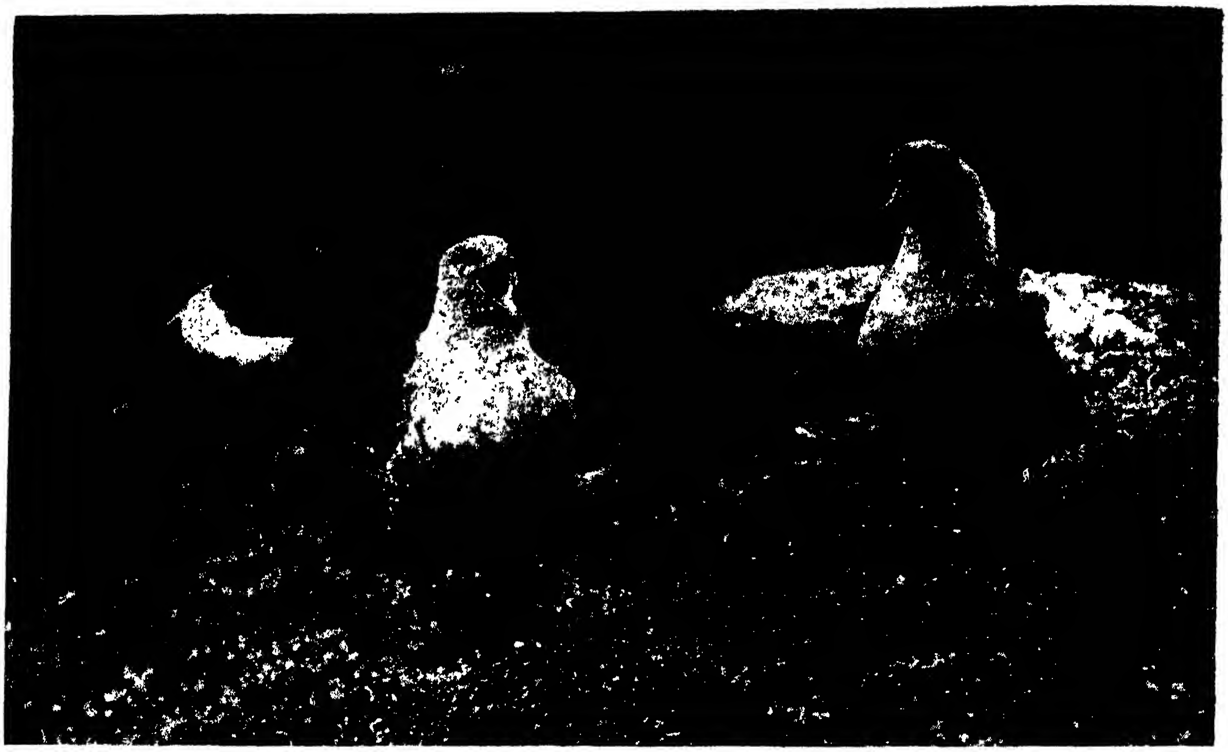
Cormorants and gannets fish actively around the British coasts, especially the rocky coasts like those of the Isle of Man and Scotland. They enjoy the herring shoals, but it is questionable whether they do serious damage anywhere unless they move inward into more secluded waters.

There are other birds which take their toll of fresh-water fishes, but here we are treading on dangerous ground, for the bird-lover will never agree with the angler. The stately heron is one of the sinners, and that cheerful bird, the king-fisher. The heron loves the marshy flats as well as riversides, and takes up its residence where clear waters are well stocked with fish.

E. N. A.

SKUA GULL, SCAVENGER OF THE SEA, AND THE PENGUIN

Four species of skua gull (bottom) occur in the north of Britain, and there is also a special breed in the Antarctic. These birds are the bullies and scavengers of the coasts they frequent, preying insatiably on other gulls and eating offal that may be floating or cast up on shore. The penguin (top) hunts its food under the sea.



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Neville Kingston

SEA BIRDS THAT ARE GLUTTONS OF THE COAST LANDS

The herring gull (bottom right) is said to have received its name from its habit of following the herring shoals, but it is much more a robber of nests in gull colonies. This is a real glutton among sea birds, for it often comes inland and attacks the turnips in the fields. The black-headed gull (bottom left) is also rather loosely named, for its head is rather brown than black. Like the herring gull, it is fond of coming inland and it eats great numbers of grubs. The Antarctic skua (top) preys upon the penguins' eggs as soon as it sees a nest unattended.

SEALS POSSESSED OF GARGANTUAN APPETITES FOR FISH

that describes the appetite of a seal. To keep a mammal, a warm-blooded animal, active and well in the sea needs a great deal of food from which the necessary heat and strength may be obtained. Fishermen often complain of the ravages of seals among the shoals and, locally, the animals may appreciably affect the fish harvest for men. But, in general, fish are so prolific that even such great eaters as the seals cannot diminish the supply The lower photograph shows a seal in company with some penguins.

Its numbers must have been very much reduced in the British islands during recent years, for, in certain parts, where it was formerly quite common, it is now rarely seen

The kingfisher, a very delightful bird, beautiful in plumage and interesting in its habits, has always been an object of interest. It is the subject of many old superstitions, and is conspicuously mentioned in the classics. Its usual method of fishing is to sit motionless on a branch or other perch (its feet are not adapted for walking), looking down into the water. So it may sit for hours until, when a victim happens to show himself, there is a lightning-like descent, the fish is captured on the dive, and the bird flies away to a suitable spot to swallow it. The kingfisher catches only small fish, but unfortunately its appetite is large. The famous laughing jackass of Australia is a kingfisher, but not necessarily a fisher of fish. Its sardonic laughter may be heard in the depths of the Australian bush, where its favourite food is small lizards and snakes.

No description of the enemies of fish could be complete without reference to those of the highest group of vertebrates, the Mammalia. It is almost as great a matter of surprise that quadrupeds so closely adapted to life on land should have returned and become fitted for life in the sea, as it is to see a cormorant swimming under water. The seals, for example, and their very, very close relations, the sea lion and walrus, are really marine dogs. They belong to the group of animals known as the Carnivora, to which the dog, cat, wolf, lion and the bears belong, but how different their habits. They are wonderful swimmers, and not nearly so much at home on land as in the sea. Yet their real mammalian nature is obvious. They must return to land to breed, they give milk to their young, and if they were kept too long under water they would drown.

The capacity of a Zoo seal for fish seems inexhaustible, yet when we remember how active these creatures are and the fact that they are warm-blooded like ourselves and therefore must expend energy in keeping a high body temperature in the cold waters of the sea, the fact is not surprising. A story is told of a sea lion in the London Zoological Gardens which happened to be "just handy" when a keeper left the entire day's fish supply for the whole of the fish-eating denizens of the gardens on an untended truck. The keeper was not away more than a few minutes, but the whole supply went and, what is more, the animal seemed prepared to present himself for attention when at great trouble some more fish were obtained. A sea lion not full grown will take forty pounds of fish in a day.

A telling description of the sea lion was given by Peck in 1853, which is well worth quoting:

"But of all created things and monsters in the world, I think there can be none that when seen near at hand wears so horrible a face and shape. . . . Nothing can be conceived more unnaturally hideous. They are the embodiment of despair. Along with the look of fierceness and cruelty, they have one of agony and suffering that makes them altogether appear to be the compelled agents of some diabolical spell or inevitable doom, like the wicked afrites and genies of the Arabian Nights. Their breathing is always like sobbing, their cries are wails; who knows what they could reveal if they could speak? The depths of the sea and the monstrous creatures that inhabit there are familiar to them, and so are the darkest recesses of the great caverns. They were created to be destroyers. There is no doubt that to support their lives they must devour an incredible number of the small fishes."

Seals occur round the English and Scottish coasts, and at one time were quite plentiful on the Northumberland coast. Complaints were received from the fishermen who believed that they caused destruction to the salmon.

The reader of this chapter will now be in a position to ask why indeed there are any fish left at all in the sea, considering the vast toll made upon them, quite apart from the ravages of man. The truth is that the sea is remarkably productive. If we look around us anywhere on land, especially where life is more abundant, we find vegetable life predominant. What would be the appearance if the waters of the North Sea suddenly disappeared, leaving the whole mass of living things lying on the sea bottom? We should see a vast, almost level plain literally carpeted with animal life. Everywhere there would be a glittering mass of fish, and hordes of worms, crabs, starfishes, and so on, would be mingled with them.

It would seem that the sea was much richer in animal life than the land, and this is actually a fact. The reason is not far to seek. On land the ultimate source of all food is the green plants. This food supply is limited by products which can only be obtained from the surface layer of the soil. In the sea microscopic plants can live as far down as light penetrates and that would be the whole depth of the North Sea, which is not very great. No parts of the sea are sterile, and some of the richest regions are in the icy latitudes where land life is most sparse.

The whole world's fisheries have been estimated at £200,000,000 per annum, and we can guess from that the amount caught, possibly not far from 16,000,000,000 pounds per annum. Yet it is doubtful whether even this attack is causing serious reduction. Certainly the natural enemies we have been describing occasion no diminution in the fish life, for quite a definite balance exists between productivity and destruction. The number of fish present in the sea must be enormous when one can capture three thousand million herrings in one season in the North Atlantic, that being only a tiny percentage of the total number present. Perhaps the explanation lies in the fecundity of the fish.

Chapter LII

Herds, Packs and Colonies

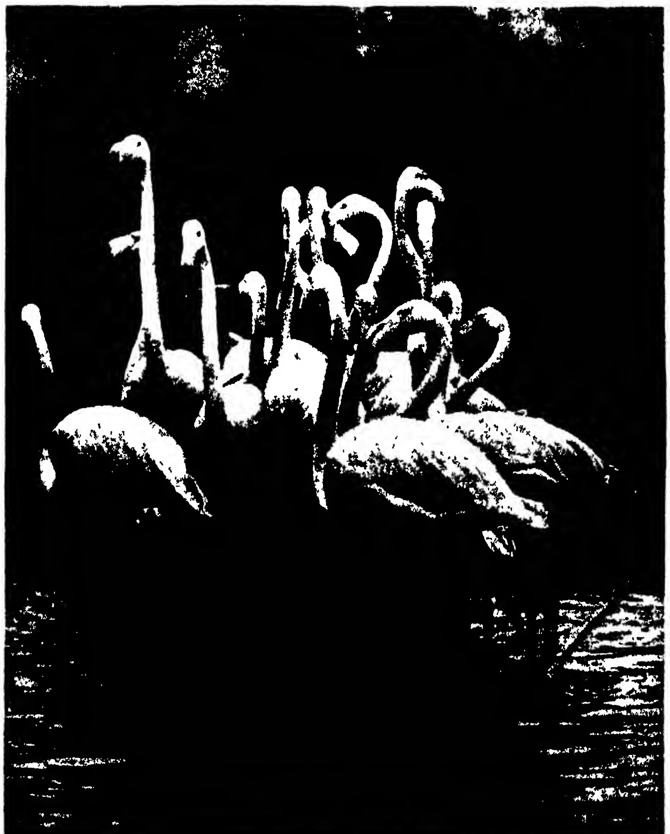
By H. Mortimer Batten

Author of "British Wild Animals and Their Tracks"

For everything in the world of men and women there is an exact counterpart in Nature, but there are many things in Nature beyond the region of our understanding. The optimist, the bully, society's victims who have tried to victimise society (and perhaps succeeded), the professional thief, the ne'er-do-well, even the altruist—every deceit and catch-penny device known to mankind has been practised for ages past, and will be practised for all time, by the children of the wilderness.

Before the days of Adam many of the highest sciences, to which we have only just awakened, or to which we may have yet to waken, existed, and were worked out in Nature. Stream-lining and camouflage, the rudimentary principles on which the whole wheels of modern evolution revolve, might have been learnt from Nature countless centuries before the Picts. Man shivered for ages on his rush mattress while the white ants were cosy in their centrally-heated palaces yet when we come across this, that or the other in Nature which seems to draw a wild creature nearer to our own lives, we throw up our hands and exclaim—"How uniquely human!" Human, indeed!—and we are only just beginning to learn many of the vast sciences which in the so-called lower world were worked to an efficient conclusion before man thought even of wearing clothes!

The herd instinct in animals should be a subject of special appeal, since we of all creatures are herd dwellers. In the wild we have two kinds of herd dwellers, those which do not need to travel for their food and therefore live in colonies, and those whose demands necessitate a wandering existence — in other words, the gipsies and the townspeople.



Neville Kingston

GRACEFUL FLOCK OF FLAMINGOES

One of the most beautiful spectacles to be seen, so far as companies of animals go, is a flock of flamingoes when they make a rose-pink cloud above the shallow water where they stand. Close by, as here, the necks seem to form naturally into a very decorative pattern.

Of one thing we may be certain, however, that no wild creature travels more than its food requirements demand. Of none is this more true than of the eagle and the falcon, commonly considered the world's greatest wanderers. Having fed, these great birds of prey are perfectly content to sit for hours till their food is digested, and if fresh food were within immediate reach, they would repeat the performance of feeding and resting throughout life.

In the days when the buffalo thousands trod the prairies, north and south each spring and autumn, from the plains of the Red River and Saskatchewan to the regions south of the Missouri, it was not restlessness which led them, but the necessity for food. It may be said that the life of the buffalo herds consisted of one gigantic migration.

Let us try to picture the massing of the buffalo herds. Spring has just come to the plains of the Mississippi, and over every ridge black streams of buffaloes are pouring. Herd joins herd till the valleys are full of them, every buffalo with its head towards the north, every buffalo obsessed by the migration fever. Still the black rivers feed the black sea, till an incredible army of buffaloes is moving across country; an army perhaps fifty miles in width and over a hundred miles in depth—the whole area black with them, shoulder to shoulder. Overhead countless birds of prey are wheeling and soaring, and in the train of the great army, ready to cut out the stragglers or to pull down the weak, prowl the timber wolf and the grizzly.

In these days it is almost impossible to imagine such a gathering of wild creatures, but the facts remain. Northwards the buffaloes moved, leaving the landscape strewn with their dead. The

Neville Kingston

COLONY OF COYPUS WHICH YIELD THE FUR CALLED "NUTRIA"

Along many of the larger rivers of South America the banks are riddled with the burrows of the coypus, furry rat-like animals, a little less than two feet long as a rule, and not unlike the beaver in general appearance save that the tail is not flattened but rounded like the rat's. Their food consists of water plants, both roots and leaves, and the under-fur is in great demand commercially, being known in the trade as "nutria." The coypus outer coat, however, is very long and harsh in quality.

rivers were still snow-coated, and there was nothing to indicate the rottenness of the ice—nothing, indeed, by which the hollow might be recognized from a general feature of the landscape. Out trod the vanguard of the great army, then came a thunderous boom as through they went—thousands being crowded to their doom, tier after tier and line after line of them forced on, by the surging mass behind, till the living were veritably ploughing their way across a bridge of the dead.

Thus thousands of buffaloes were drowned and trampled in the great prairie rivers every spring and autumn, and it is a fact that islands exist on the Mississippi and the Missouri which were built up by the uncountable stranded buffalo hulks. For several weeks each spring these mighty waterways were unapproachable owing to the stench of the buffalo carcasses piled along their banks in ridges for many hundreds of miles.

The buffaloes most certainly left an indelible trail behind them, an imprint on the face of the country from which man wiped out their thousands in the space of eight years, for by ages of travelling, the buffaloes had learnt the best routes through the hills and over the mountains. Thus the buffalo trail became the pack trail, and the pack trail the trail of the Red River cart, and to-day the Continental railways, with their Pullman saloons and their observation cars, thunder through the passes by the very routes once trodden black by multitudinous hoofs that have long since disappeared.

These great armies of buffaloes consisted of individual herds, or clans, which normally lived their lives scattered over the country, each herd keeping to itself. An average herd might number between twenty and fifty, and it may be taken that they were all related, great-grandmothers, grandmothers and mothers with their respective offspring. I am inclined to think that most wild creatures which live in herds do not so easily lose sight of their relatives. Recently, in the Forest of Atholl, I was watching a herd of red deer hinds numbering fourteen. The leader of the herd, obviously the mother mind, was an old grey hind, and the others were watching her, waiting for her decision, waiting for her to lead, and as I took stock of them, I saw the unmistakable family likeness from hind to hind, the grey markings and the distinctive features of the old leader. She, no doubt, was the great-grandmother of that clan, for though in the wild, as in our own world, the males show a tendency to wander off and seek their fortunes in distant ranges, the females cling to the mother, hence the herds.

If this is true of the deer, and in my own mind I am certain that it is, it was proven of the buffalo. There existed a certain buffalo robe which was much treasured by the Indians on account of its silky and curly texture. This robe was of the great-grandmother of the clan, so beloved and respected by her children that one or other of them was forever licking her coat, hence its particular texture. If an old grandmother was killed or wounded, the other buffaloes would hang around, refusing to leave her.

AMERICAN BISON WHOSE VAST HERDS FORMERLY ROAMED THE MISSISSIPPI PLAINS

When the time for migration arrived, the huge herds of bison (often inaccurately called "buffalo") used to form a moving mass, shoulder to shoulder, that might cover an area a hundred miles long and fifty miles wide. In the spring the ice covering the rivers would be getting thin so that as these tramping thousands crossed, the thinning surface would crack and the vanguard of the huge army drown. But the rest crossed on the piled bodies of those in front. These photographs are from the film "The Last Barrier."

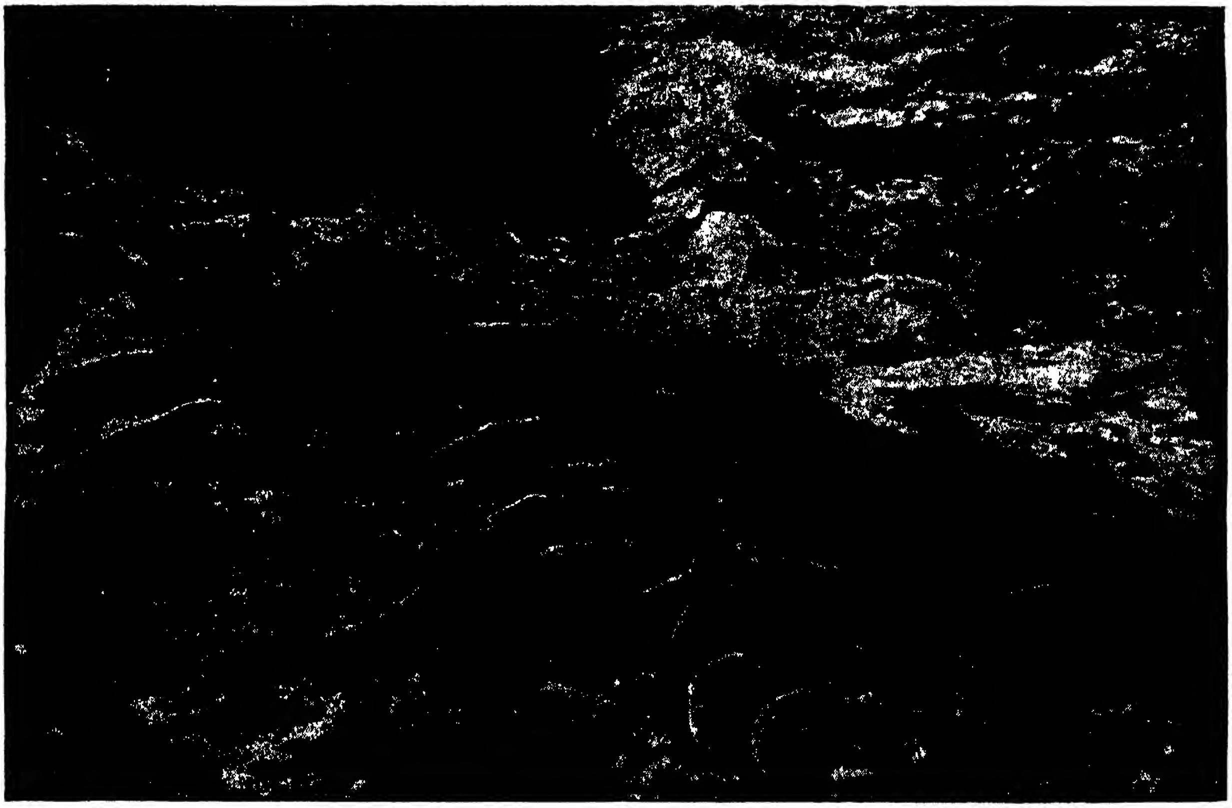
HERD OF SCANDINAVIAN REINDEER AT THE HEAD OF A NORWEGIAN FIORD

During the summer the reindeer of Norway are to be found feeding on the grass of the valleys, while in the winter the herds go up the mountains and eke out a living on moss and various kinds of lichen. Wild herds are scarce now in Norway and only occur in the wilder parts. Outside that country the reindeer wanders through Lapland to Eastern Siberia. The wild herds are not large and contain only a few adult males, who act as sentries. But in the domesticated state the reindeer flourishes, for it has been kept by man for centuries in Scandinavia. At one time it occurred in England, and seems to have been hunted in the north of Scotland as late as the twelfth century.

J. D. Melhuish

TROOP OF GIRAFFES FOLLOWING THEIR LEADER AS THEY FLEE IN ALARM

Giraffes have greatly dwindled in numbers in South Africa, and it is only their extraordinary ability to exist for months at a time without drinking that has kept them from extermination in certain districts. They retire to waterless regions like the Kalahari Desert, where the herds have been found numbering perhaps fifteen or twenty head, while herds of seventy or more have been seen in the past. Our photograph shows a herd which has been alarmed by the approach of a photographer, and is making off in single file, as these creatures do when frightened. The leader of the herd will take them through the thickest bush unhurt, where no man might go on account of the thorns. But the giraffes, hides are impervious to such things.



J. D Ratton

HERD OF SEALS BASKING ON ONE OF THE SHETLAND ISLANDS

This remarkable photograph of a seal herd was taken in the Shetlands, and shows a sight not often to be observed, much less caught by the camera in the British Isles. It will be seen that one or two of the animals have noticed the presence of the photographer, perched high above them on the cliff and they are lazily turning their heads towards the camera. But the bulk of the herd is undisturbed and lies quite peacefully on the craggy ledge raised a foot or two above the water.

even though they remained at the cost of life. The passing of the buffalo was, indeed, a story as full of drama and pathos as any great history of wild Nature, but, alas, it could not be otherwise. The buffalo had to go. Imagine in these days the trampling of such unmanageable multitudes through the heart of a settled country!

OFTEN in the seeming folly of creatures which dwell in herds there lies the seed of a great wisdom. We in our ignorance are too apt to criticise and to compare the ways of animals with our own ways, but we must realize that though this creature and another may be an absolute fool with regard to the ways of mankind, it may yet stand out as wonderfully wise in its own world. How would the wisest of us fare, I wonder, if we had to change places with some of them?

As an example, sheep are generally set down as the most stupid of creatures, but, believe me, there are few animals more sagacious than the wise old ewe of the hill flock, chosen as leader because the rest have learnt that where she leads it is safe and wise to follow. The saying "blindly follow each other" has passed into an idiom of contempt, but among such creatures as dwell in herds, the rule of follow the leader is an inflexible and universal rule of life. As well might the soldier break formation as the herd-dweller break the line. The leader, I say, is chosen by common suffrage because she is best able to lead, and where she goes in a moment of danger the others will follow, be it over the brink and into giddy space. Thus, the panther lying in ambush is trampled down or beaten aside; even the grizzly cannot face the battering-ram assault of the breaking herd, whereas, if the individuals scattered they would be hunted down one by one and slain. You will notice that when a sheep breaks, the shepherd never sends his dog after it, for no dog can turn a breaking sheep. It will dash itself into a rushing river or even jump over a precipice that lies in its way sooner than turn, once its line of travel is decided upon.

It is much the same with the red deer. Great artists invariably paint a magnificent stag leading the herd, but generally it is a wise old hind. She knows the deer paths through the mountains, older many of them than the oldest human highways, and when her herd-mates begin to lose their brightness of eye and their lustre of coat, the wise old hind knows what ails them, and it is she who leads them to a distant place where certain herbs grow, or perhaps down to the sea-shore, where they can lick the medicinal brine from the rocks.

Major Radclyffe Dugmore

Major Radclyffe Dugmore

BUFFALO AND HIPPOPOTAMUS HERDS IN THEIR AFRICAN HOMES

To procure the lower photograph it was necessary to ascend a tree, and wait for the buffalo to come—and go. The African buffalo is considered by many hunters to be the most dangerous animal in the world, since it will attack without further provocation than the nearness of a human being, and will wait at the foot of a tree if its intended victim should climb one Above is a scene on a mud-bank in an African river showing just how a herd of hippopotami keep together when resting.

WILDEBEESTE AT A WATER-HOLE IN THE KRUGER NATIONAL PARK

So shy are the wildebeeste or gnus of Africa, that the photographer had to spend fourteen hours up a tree near a water-hole to obtain this view of the wild life of a herd. At one time there were enormous numbers of wildebeeste and the black variety were full of curiosity about any human beings they might see, and used to gallop round hunters' wagons in a playful fashion. But persecution followed the white man's invasion of their territory, and in becoming scarce they also became so very shy that it is now impossible to approach them near enough for photography on the open plains where they live. The bulls, which keep watch, sometimes standing quite still for several hours, are extremely keen-sighted.

E. N. A

WOLF THAT IS SOMETIMES SOLITARY AND SOMETIMES RUNS IN PACKS

In the spring and summer wolves usually run alone or in pairs, but when the winter comes they form a pack for hunting such creatures as they could not deal with singly. The cunning of the pack is amazing, the leader winning the place of honour by its own superiority. A pack of wolves has brought concerted running to such an art that every individual of a pack can pass and leave only one trail—that of the leader. All the rest place their feet exactly in the leader's snow prints and so avoid having to break an individual trail.

As the buffalo once trod the prairies, so even to-day the caribou make their great journeys north and south, across the Barrens of the New World which are equivalent to the tundra of the Old. They stick to their recognized routes, and I myself have seen a caribou path deeply trodden into the earth, and as clearly defined as a human highway. Now and then a city may spring up along one of their lines of travel, and the antlered pilgrims have been known to walk through its avenues, staring wide-eyed at its human dwellers. Great lakes may bar their way, blizzards may hinder their progress, but the caribou have been evolved for these great journeys across the bleak lands they haunt.

Every hair of a caribou's coat is a hollow quill, so that it swims high out of the water, buoyed up by its natural lifebelt, and it can swim for miles. The hoofs, too, are specially designed, for the arrangement of the joints is such that when the animal treads on soft ground or snow, the splay opens enormously, and the whole hoof comes in contact up to the forelock joint, thus preventing its sinking. Moreover, the hoof clicks loudly at every step, and this constant clicking keeps the herds together, just as the twittering of small birds heard high in the heavens at night-time keeps the migrating flocks together. The Indians of the Barren Lands lie in waiting for *la fièvre* of the caribou, and massacre hundreds of them, the meat being cached underground, where it freezes solid and will keep for months. So a long line of caches is built across the Barren Lands, but should the caribou, ever whimsical, pass by a different route, the Barren Lands Indians may find themselves face to face with starvation in a day.

The caribou is not swift; his maximum speed probably does not exceed fifteen miles an hour, but he can keep it up for hours on end, and the herd you startle at daybreak may be a good hundred miles distant by dusk.

AMONG certain creatures which live in herds we find markings which, on the face of things, seem to bear evidence contrary to Darwin's theory, which is that no creature has acquired a marking or an attribute otherwise than what it has evolved for its safety and betterment. Why, then, the white tail of the rabbit, which betrays him every time, and yet is of inestimable value to his fellow colonists in that it spreads the news of danger? The saying that the white tail serves to deceive the eye will not bear close scrutiny, for why catch the eye simply to deceive it? Better far to escape observation.

When a rabbit rises and runs, he unwittingly hands on the warning to those around him, and taking the hint, they steal away, so that the news quickly spreads two fields ahead of the man with the gun. In the dusk of the evening I have shot more rabbits than

Herbert G. Ponting, F R.P.S., Copyright

PENGUIN COLONY AT CAPE ROYDS IN THE ANTARCTIC

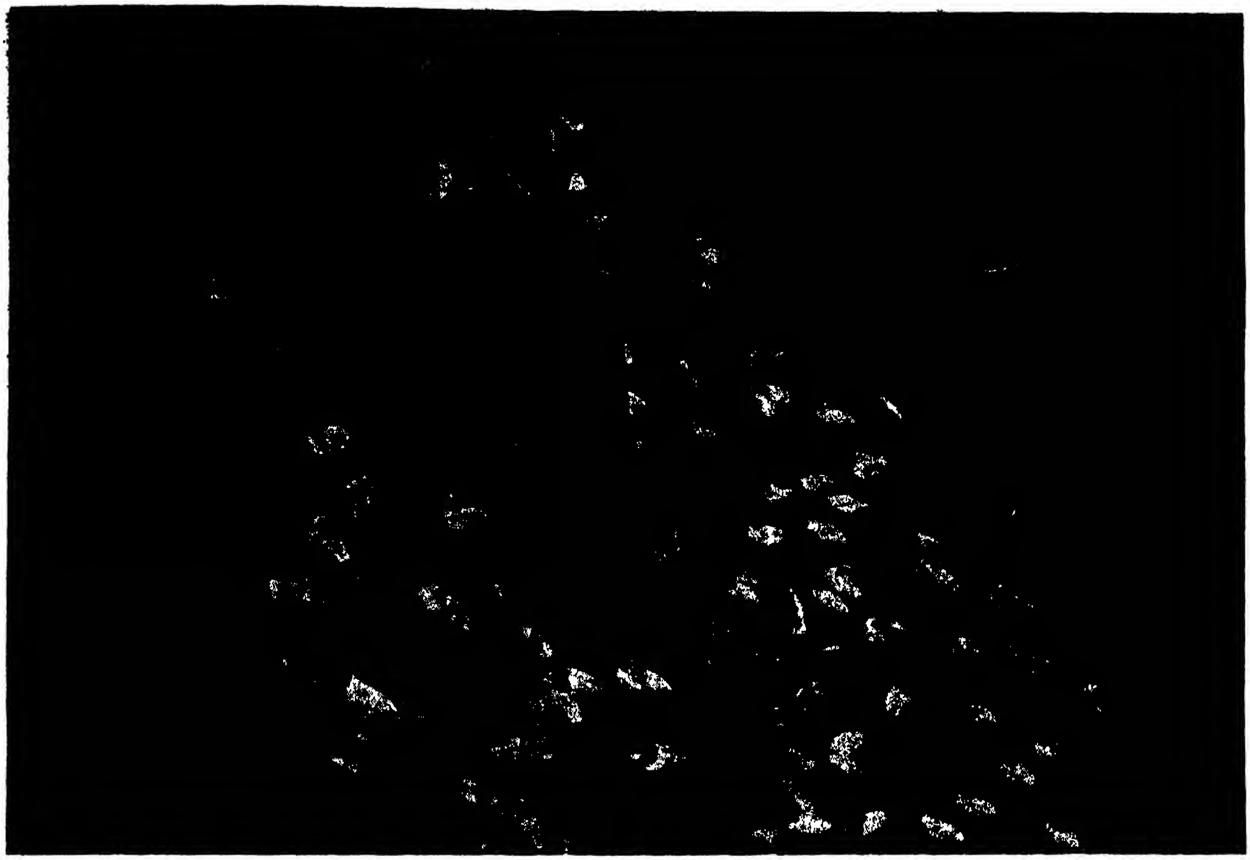
The Adelie penguins may be seen nesting by the thousand in the Antarctic. They each collect a little pile of stones and on this unpromising "nest" lay their eggs. Each pair have to guard vigilantly against their neighbours who are waiting to steal a stone for themselves from someone else's heap. One of the Antarctic expeditions noticed that the penguins used to go about in great parties with no other apparent object than to see the country, considering that they feed entirely in the sea. In parties, too, they used to visit the explorers' camp.

I can remember, owing simply to that white danger flag, but a more impressive example is afforded by the white stern disks of the antelope, which normally lives in herds. Ordinarily, the white disk is hardly noticeable, but immediately an individual antelope becomes alarmed, every hair stands on end, and the disk shines like an aluminium frying-pan, catching the eye not only of the lurking foe, but of every other antelope within the range of visibility. Simultaneously with the erecting of the hair, musk glands in the centres of the disks come into play, so that should the visible warning fail, the scent warning will at least reach those down wind.

Now, could a more elaborate system of self-advertisement be imagined? Could a creature possess any feature more betraying in itself and detrimental to its own individual safety? Yet, to its herd mates, to those dwelling with it, the attribute is of immense value. Evolution cannot, of course, have brought about a destructive feature, but in the case of animals which dwell in herds, the survival of the individual has but one safe foundation, which is the survival of the herd. Thus, we come back to a set of rules governing their protection which are quite different from the rules which govern solitary animals. We come back to the rule of the herd which will dash itself over the edge in pursuit of the leader.

Creatures which live in herds are generally the most sagacious, because the best brain governs the movements of the rest and, as I have said, a pack or a herd generally consists of a family. A pack of timber wolves, for example, consists of the parents and the cubs of that year, and by early spring the parents have the cubs pretty well trained. In Algonquin I have heard wolves ranging for game night after night, and in the morning have seen the signs of their passing, the cleanly picked backbone of a deer with skull intact. We have stood these grim tokens up in the snow to serve as signposts, and, believe me, there is not much that the wolf-pack does not know by mid-November.

They are not swift, and when running a deer timber wolves probably run no faster than a good human sprinter, yet they work so well together that the swiftest of creatures has no chance. With them hunting is a great science, and every trick of the ambush and the relay chase is known to them. On one occasion we fired into a pack in full cry along a blood trail, and owing to the clearness of the

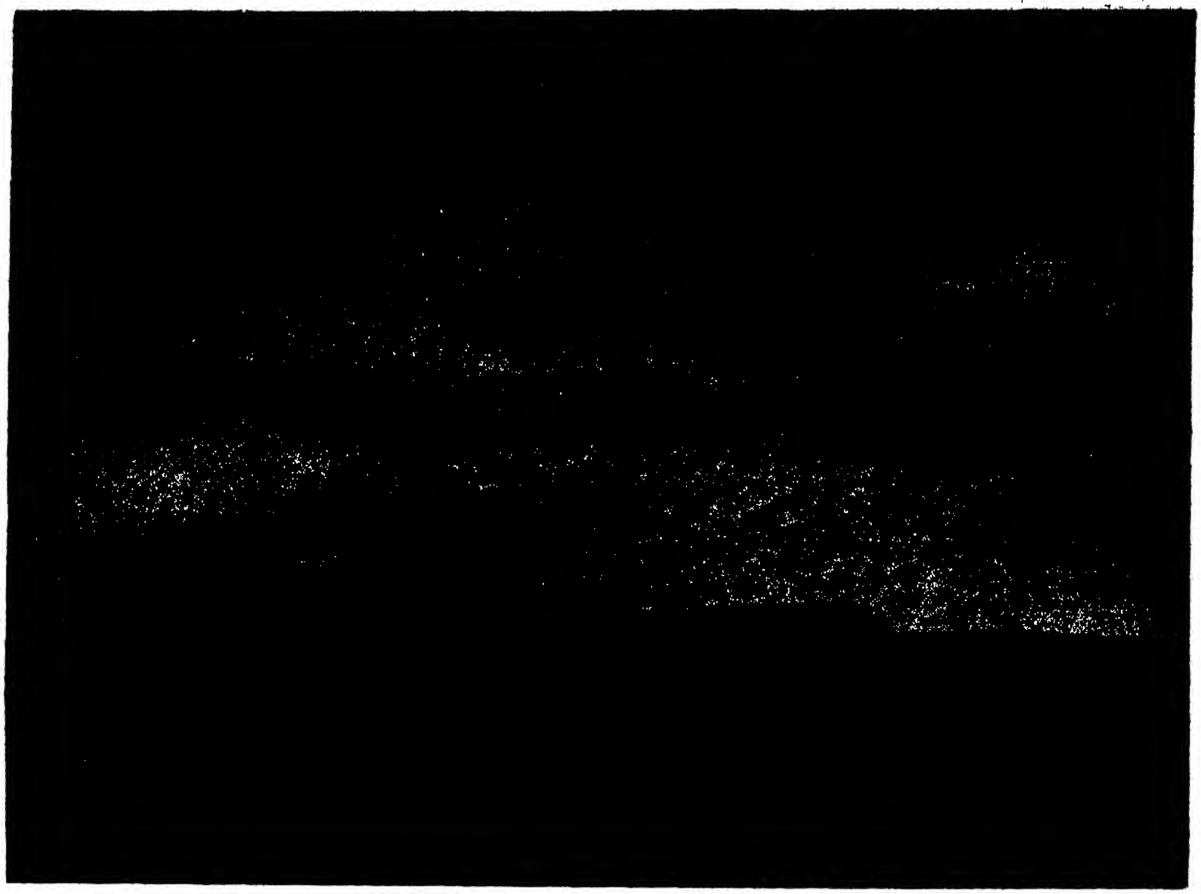


Mortimer Batten

Chas. Barrett

GANNETS IN THEIR NOISY COMMUNITY AT NESTING TIME

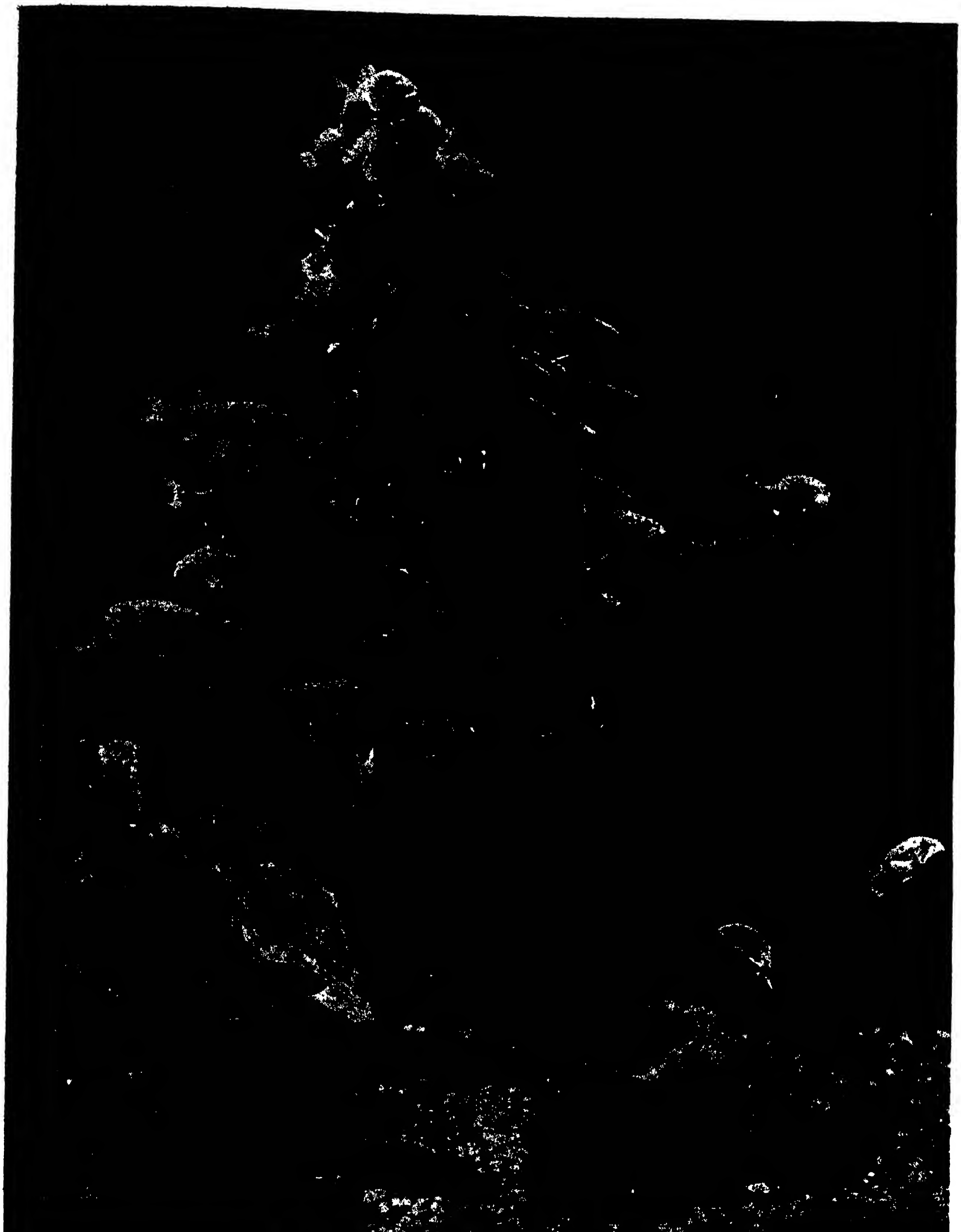
In Scotland, Ailsa Craig on the west and the Bass Rock (top) on the east are renowned for the gannet colonies where thousands make their nests annually. During the time the birds are building the nests the din made by the colony is terrific since the pieces of grass or seaweed, out of which the nest is made, are continually being pilfered and fought over. Gannets are more abundant in the Southern than the Northern Hemisphere and our lower photograph was taken on an island in the Bass Strait between Tasmania and Australia.



Natural History, N.Y.

BIRD LIFE IN THE MASS: PELICANS AND SEA GULLS

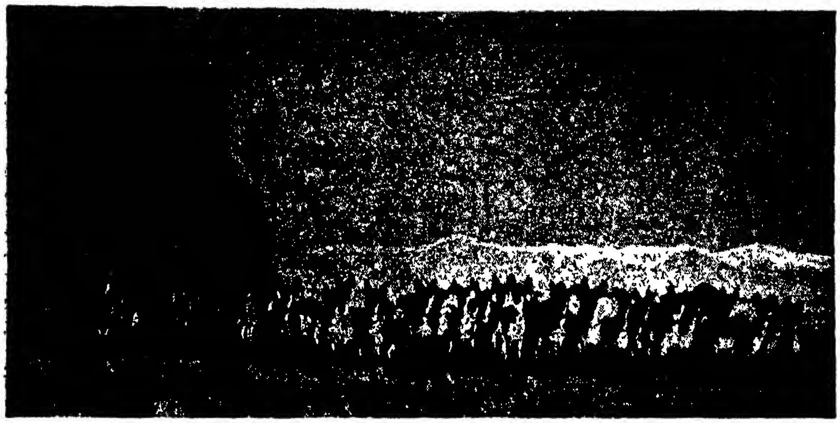
By first constructing a " hide " and then having the young birds driven towards it the lower photograph was obtained, for the parent birds, though very suspicious, followed their young, every now and then flying away in alarm, but soon returning. The old birds seem to feel the responsibilities of parental care and try to keep their offspring in some sort of shelter from the sun, restraining any efforts to stray by vigorous pecks. In the upper photograph we see a vast cloud of gulls attracted to a meat-packing works by the presence of offal.



Elwin R. Sanborn

AMERICAN BASS KEEPING WARM IN WINTER TIME

Found widely distributed in the rivers and lakes of the United States, the handsome bass are related to the perch of Britain, and provide much good sport for anglers. These fish have the strange habit of huddling together in winter time with their heads all pointing in the same direction, as we see here. This extraordinary cluster, which seems to hang in the water by means of some invisible suspension, was photographed in the New York Aquarium. The fish, it will be noticed, have very handsomely marked skins.

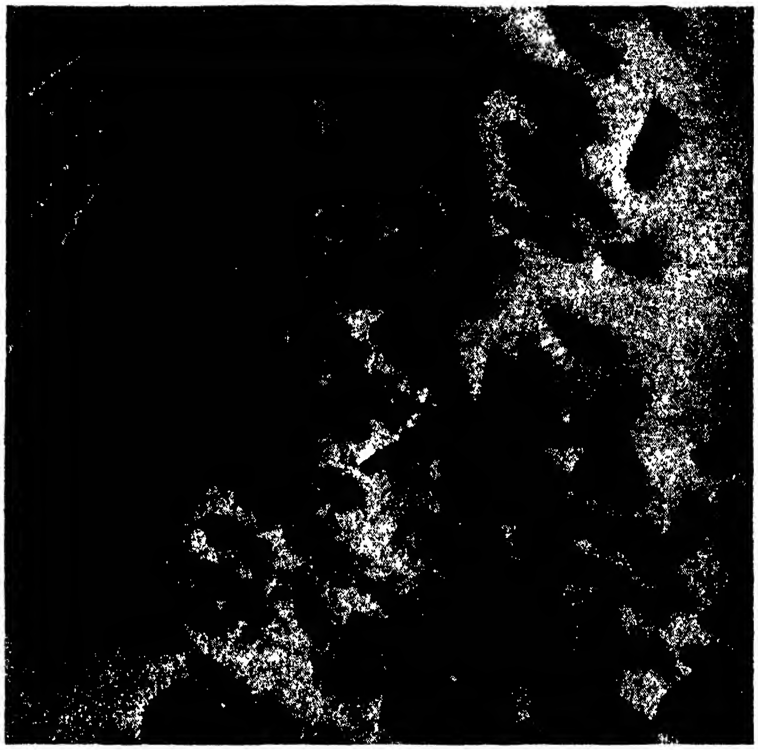


Natural History, N.Y.

atmosphere, they looked hardly a hundred yards off, though they must have been fully a mile distant. As the bullets ricochetted and boomed across the ice, casting up white spumes, the wolves turned and streaked in single file for the nearest cover, but going up, we found in the snow the tracks of only one wolf. The others had placed their feet exactly where the leader had trod, so obtaining the easiest going without each one breaking trail for itself.

Such is the wariness and the cunning of timber wolves, such is the denseness of the regions in which they live, that I have known men who have lived the whole of their lives in wolf-infested forests, who have taken scores in their traps or by poisons, and who have heard them almost nightly, yet who have never seen a single wolf alive and free.

Many of the higher animals that dwell in packs are human in the extreme; the old dog baboon will face death unflinchingly to save a " woman " or a " child " of his clan, and those who have visited Gibraltar will have heard almost incredible stories of the social circles and the human reasonings of the monkeys that come down from the Rock from time to time.



M. H. Crawford

CROWD SCENES IN NATURE; CATERPILLARS AND ANTELOPES

The lower photograph shows a batch of tiger-moth caterpillars just about to begin a life of hard feeding and rapid growth. Above is a herd of antelope coming to the feeding-ground at the Mount Dome antelope refuge in California. The animals have seen the camera, and are huddled together, watching, suspiciously, for danger.

So much, then, for the gipsy folk, but those which dwell in cities are equally interesting. Space does not permit a description of the beaver city with its dams and its canals and its flood gates and its lodges, nor yet of many of the cities of the insect world. Darwin said that but for earthworms, which turn and air the soil, nothing could grow, but he evidently forgot the vast and fertile regions of our great continents which for several months are frozen, and where there are no earthworms. In so far that the earth must be turned, Darwin was right, and where this has not been done by worms, ground-burrowing rodents have taken their place. For example, look at the prairie dog cities of North America. If a dog city be pegged out and watched, it will be found to be constantly creeping one way or another, and ten years hence it may be centred half a mile distant. Thus through the ages burrowing rodents, including the mice millions, have rendered the earth fertile that they themselves may live upon it, just as the squirrel, by burying nuts, then forgetting where he has buried them, extends the forests with the valuable nut-bearing trees on which his race depends.

We speak of the wonders of bird migration; how birds traverse seas and continents, coming and going to the day, but what about the wonders of the migrants of the sea, who cover distances as great, or greater, and that through unfathomable depths where there are no landmarks—the four years' journey of the elver eels from the depths of the Sargasso Sea; or the annual movements of the herring and the mackerel which are more prompt in their migrations than the cuckoo and the swallow.

Chapter LIII

Bird Friends of the Farmer

By H. J. Massingham

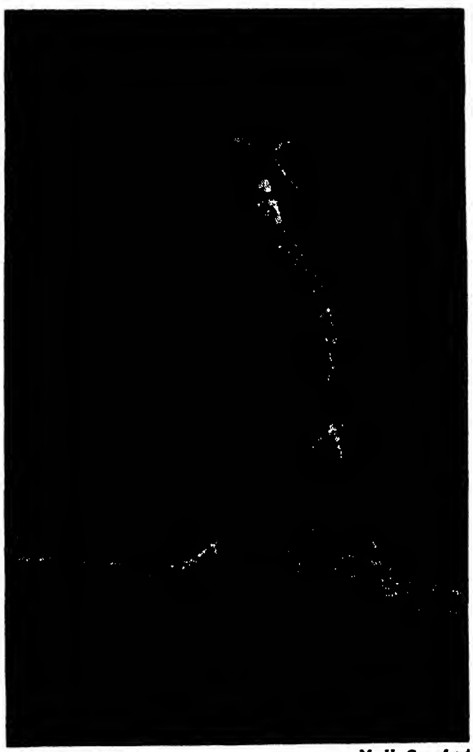
Author of "Some Birds of the Countryside"

No subject—thus I would like to begin this article—is so littered with ignorance, prejudice and confusion as that of the economic status and utility of wild birds. Unfortunately, I am unable to think of any other subject concerned with the values, material or spiritual, of life which is not equally clogged with the same importunate interferences. The reasons are not far to seek. Nowadays we—and by "we" I mean those powerful enough to do so—interfere with everything. It is an age of interference, and has been so for a hundred years. At the same time, we are martyrs to certain abstractions—"Progress," "The Conquest of Nature," "Morality," "Science," and a round dozen of others. We are too much in a hurry ever to pause and ask what we mean by these words, and whether all the results we achieve by them are worth while. We pursue these abstractions because they are a means to power, and the acquisition of power, which, of course, implies interference, is the main object of Western civilization. Such questions as the value of power, whether it makes people wiser or happier and what use we are to make of it when we have got it, are pure irrelevancies. The object of life is power; the means to acquire it are institutional or mechanical and the driving-force to achieve power is, of course, the love of power itself.

This is no idle excursion away from our theme. The inter-relationship between birds and vegetation is an exceedingly intricate mechanism which took nature millions of years of experiment and labour before just the right balances and adjustments were in proper working order. Up to the nineteenth century man's dealings with nature did not affect the equilibrium very materially. Changes in the relative abundance of certain species over others, variations in the food-habits of birds living in the neighbourhood of man, were inevitable consequences of the invention of agriculture. But it cannot be said that these changes amounted to a serious dislocation of natural balances. Birds and crops and insects went on playing their respective parts in the complex interplay of natural economy. Then came the nineteenth century, the unprecedented advances of the sciences, the discovery of a new deity "The Conquest of Nature," and the capacity, extended to a large number of people, of taking life very much more expeditiously and comfortably than ever was possible before in the whole history of mankind.

These new powers were not, however, accompanied by any corresponding advance in sanity, wisdom or good feeling. Man in other words was given a new lease of power without any but the dimmest idea of how to use it. Consequently he misused it, as any child will make mischief with a revolver if he gets the chance of handling it. The way that the last century handled its new powers was to make chaos of that infinitely delicate mechanism commonly known as the "Balance of Nature," that is, the mutual interdependence of all forms of life upon each other scaled to that nicety where no one type, genus or species of living thing preponderates to the undue disadvantage or the exclusion of another. The Great Dislocation happened in so many different ways that I shall not even try to give more than a very few cursory examples. In order to enable retired stockbrokers to kill game-birds in large numbers and without too much trouble, the game-keepers made away with the birds of prey, with the result that mice and voles and sparrows exultantly multiplied to such an extent that the farmers began to lose hundreds of tons of crops and roots every year.

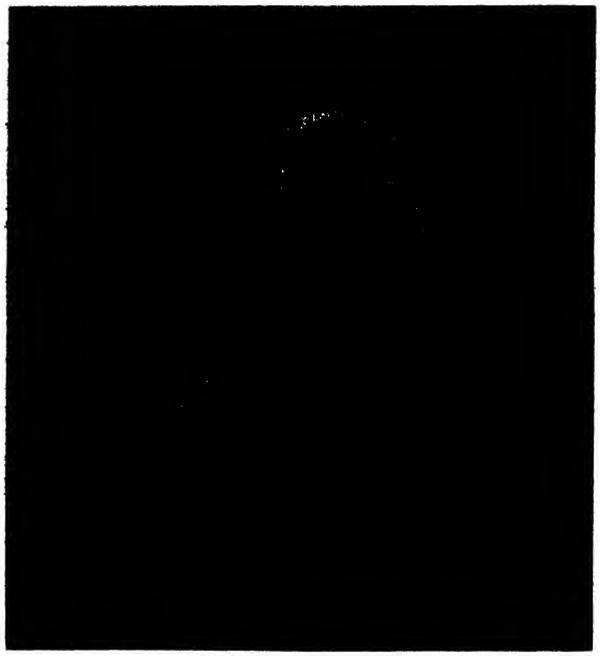
The decline of agriculture, precipitated during the twentieth century, was made the occasion after the War of a concentrated offensive against the very birds who made a livelihood out of their hosts of insect foes. A war of extermination was waged against the birds that frequent orchards because some of the fruit was pecked by some of the birds. It never occurred to the zealous fruit guardians to inquire into the feeding habits of these birds over the rest of the year and so to estimate to what extent the amount of fruit consumed or spoiled by them was



M. H. Crawford

YOUNG THRUSH WITH FULL BEAK

For about nine months of the year—the months when our food supplies are growing—the thrush feeds largely on harmful insects and grubs. Here is a young bird with its beak full.



Ralph Chislett

BLUE-HEADED WAGTAIL, AND A RED-BACKED SHRIKE WITH A MOTH

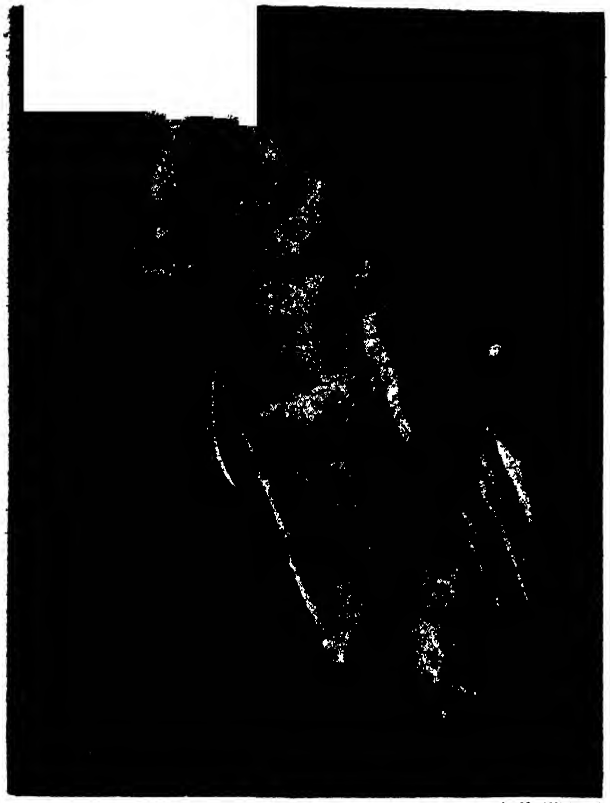
Among the casual visitors to Britain is the blue-headed wagtail (left), distinguished by its blue-grey head and neck. It often makes its nest right in the cornfields, where it feeds on insects and their grubs. It is also very fond of flies and is a friend to the grazing cattle, fluttering to within a foot or two of their muzzles to snatch at the tormenting insects. The red-backed shrike (right) visits England in April or May, and proceeds to capture large quantities of mice and beetles, later on attacking wasps and moths.

compensated for or overborne by their checks to the inconspicuous and far more insidious insect larvae which could only achieve maturity on a fruit diet. Yet it is certain that if the popping of those well-intentioned guns in the orchards had not been at last partially silenced by the passionate efforts of a few intelligent observers, fruit cultivation in this country would have perished with its insectivorous defenders.

SINCE it will be tedious to multiply such instances, I will wind up this census of the Kingdom of the Blind with two very striking illustrations. One concerns the world-famous guano islands off the coast of Peru. These islands were once inhabited by species of gannet, pelican, cormorant, tern, petrel and shearwater in such countless numbers that they passed to and fro between them like scudding clouds before a sou'wester and hid the eternally blue heavens. In the course of centuries such huge deposits of bird-droppings were accumulated that the isles actually rose many feet higher from the sea. The value of the guano deposit as a fertiliser for the barren fields of the mainland plain between the coast and the Andes was greatly enhanced by the aridity of the atmosphere, and it was through these birds that the ancient Incas accomplished such prodigies of making the desert fruitful. Consequently they were very strictly protected by the archaic Children of the Sun.

In the middle of the Victorian period, however, the islands were ceded by a corrupt administration to various British and European firms. A time of cut-throat competition ensued. Coolies, slaves in all but name, were imported in British ships to die by suicide and over-work in such numbers that they became mummified in the guano, the birds nested in their empty skulls and the modern diggers find cartloads of human bones. In the scramble for guano and nothing but guano the birds who supplied it were killed off by the hundred thousand. When a wiser government took over the islands after a fury of carnage and exploitation lasting for nearly fifty years, only about one-tenth of the most economically valuable birds in the whole world remained to scream the good news of the exploits of progress to the new century. And to-day the existence of Peru as a nation practically depends upon the regular supply of guano dug out of the desolate rocks sticking out of the Humboldt Current with its super-abundant wealth of marine life for the birds and sea-lions to feed upon.

The second illustration is like a parable from Hans Andersen. For many years all manner of boards, councils, conferences, associations, committees, assemblages and other black-coated teams have been vociferating to a mighty crescendo that as many a sea-bird lives on fishes, and fishes were obviously created for the sole purpose of entering the stomach of man alone, a holy war must be declared on the fish-eating birds. It was calculated that since an average of twenty-five birds a day was captured by the St. Andrews fishermen among the shoals, these birds must dispose of 26,880,000 fishes per annum. The fact that only a certain proportion of the finny tribes are food-fishes and that even the abandoned gulls, terns, cormorants, puffins, guillemots and razorbills could not be fishing all day long and every



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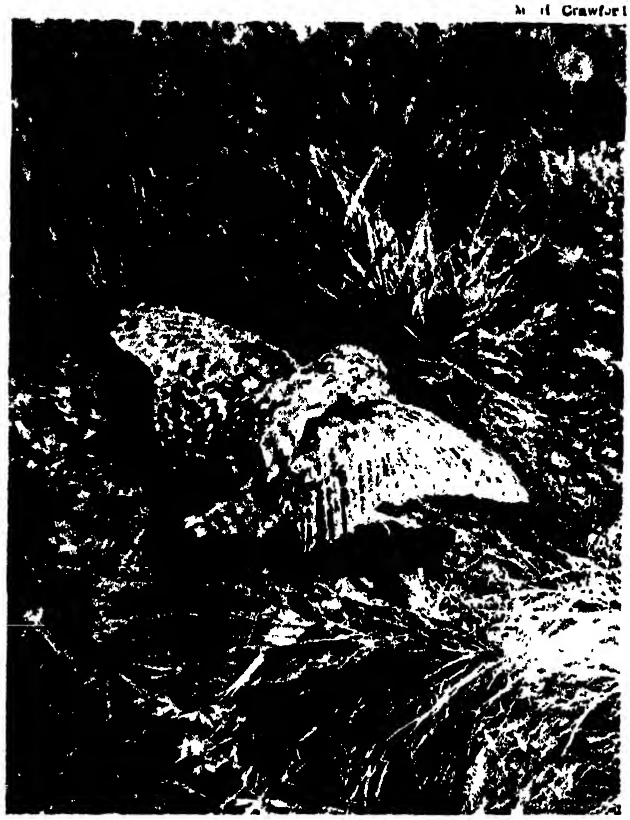

G. Hearn

THREE OWLS WHICH DEVOUR FARMING PESTS

Although the little owl cannot properly be called a British bird, large numbers have been introduced into the country from time to time. In the lower photographs we see two of these birds which have joined the war against farming pests. One has caught a big mouse (left), while the other is pouncing on a mole. The barn owl (top left), or white owl, is widely distributed over England and Wales. It feeds largely on voles, and rats and mice. The long-eared owl (top right) frequents woods, and devours moths, beetles and mice.

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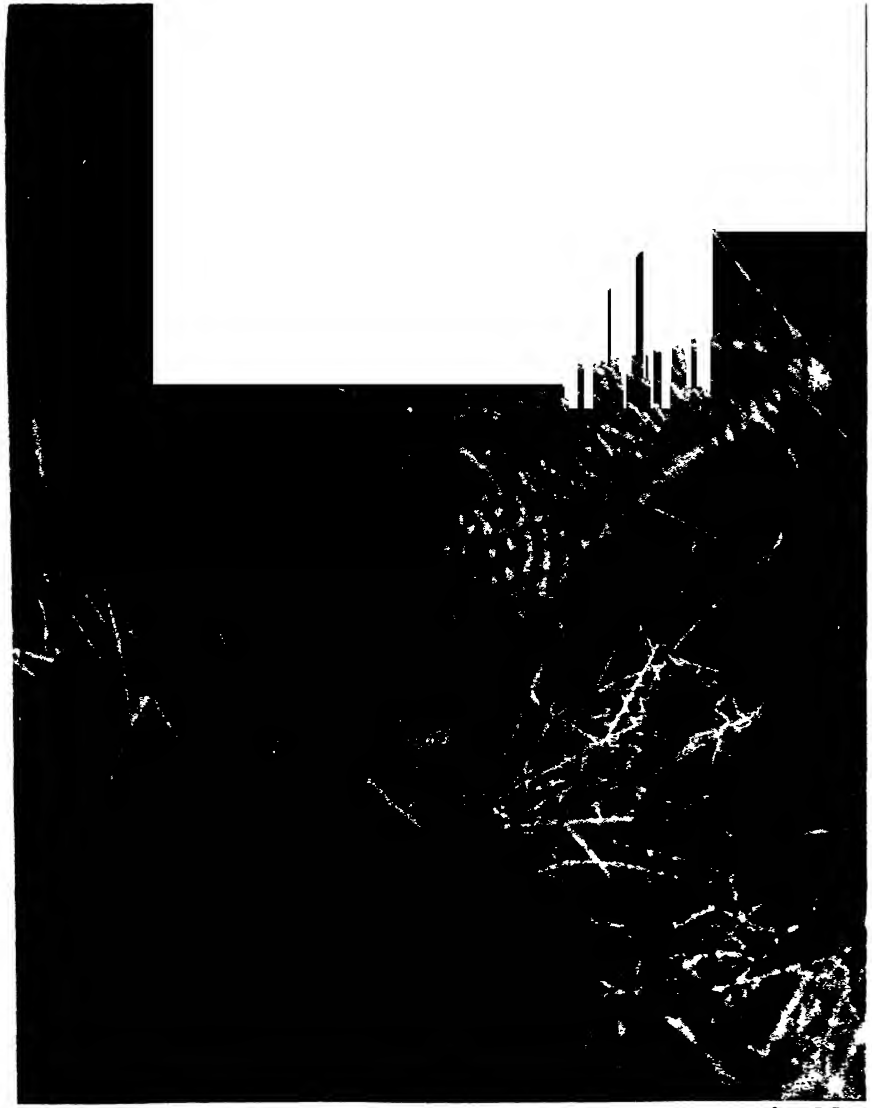
LONG-EARED AND BARN OWLS, DESTROYERS OF VERMIN, DISPLAY THEIR FIERCE DISPOSITIONS

During the autumn the numbers of the long-eared owl (left) are greatly raised by migrations from the Continent. This owl takes possession of an old squirrel's nest or the deserted home of a magpie or crow, and sets out at night in search of rats and mice. The brown owl (right) haunts the woods and often lays its eggs in a hollow, ivy-covered tree. It allows itself a fairly generous diet, including voles and rats and small birds, and will occasionally take a squirrel or even a fish that is swimming near the surface. Moles and insects are also readily eaten by this formidable bird, which has a wing span of about sixteen inches. Strangely enough, this owl seems to be unknown in Ireland, but is common in Great Britain in wooded or rocky localities.



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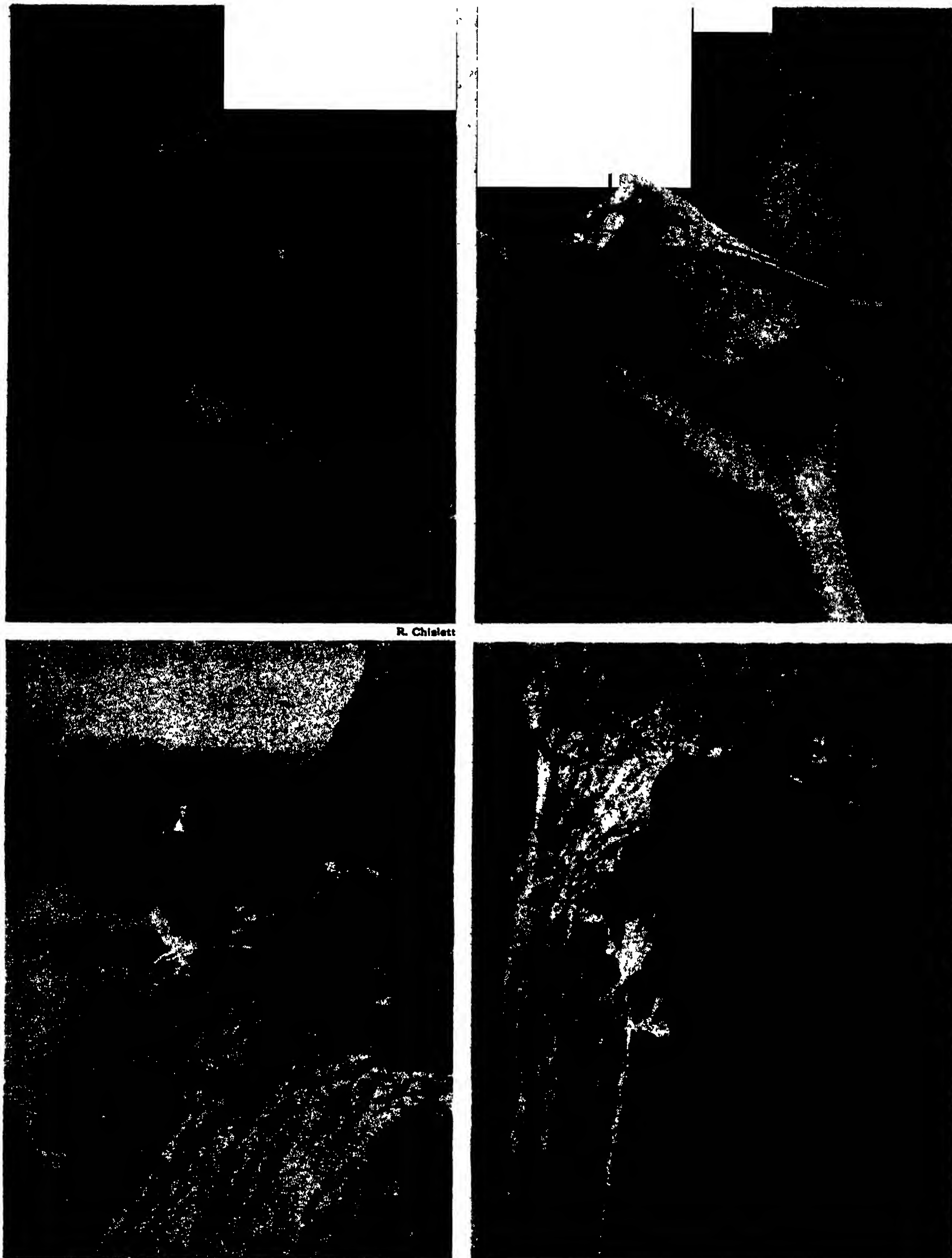
CURLEW, THE FARMER'S FRIEND WHEN YOUNG, AND THE MOUSE DESTROYING KESTREL

Curlews make a simple nest (left) of grass and leaves on the open moor and the young, when hatched, stay near at hand for a few days, after which they begin to pick up a living in the surrounding country. Insects, spiders and snails are plentifully eaten, but after a time the birds take to the sea-shore and feed on crustaceans and marine animals, when they cease to be of service to man. The kestrel (right) may be distinguished in the air by its habit of flying up into the wind and hovering for a time. It folds its wings and falls like a stone upon its prey, which consists largely of mice, particularly in northern England and Scotland. In the South the kestrel also eats grasshoppers and beetles. It is one of the farmer's very best friends.



R. Chislett

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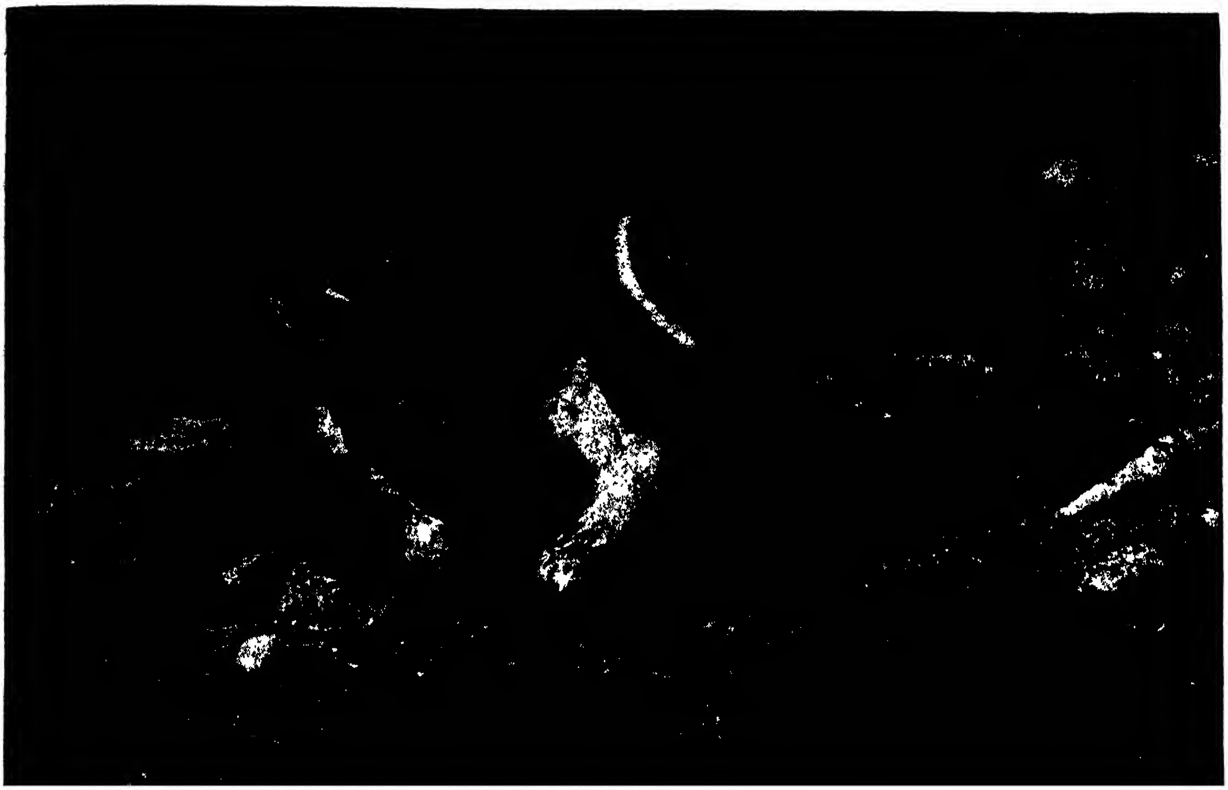
INSECT CATCHERS OF FIELD AND GARDEN: TREE SPARROW, STARLING, ROBIN AND BLUE TIT

The tree sparrow (bottom left) hunts the trees for insects and caterpillars, and nests in holes in the trunks or branches. The starling (bottom right) was formerly of good service to farmers since its food ordinarily consists principally of insects, grubs, and slugs. But the number of starlings has now increased alarmingly and the birds have turned their attention to eating seeds and fruits. Above are a robin (top left) with a beak stuffed with insects from a garden, and (top right) a blue tit, a great searcher for grubs



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RINGED PLOVER ON ITS NEST BESIDE THE SEA-SHORE

The ringed plover is one of those birds which pick up much of their food along the sea-shore but make excursions inland for a change of diet. This particular plover nests, like the Kentish plover, on the shore, often not far from high-water mark, and finds sand-hoppers and shrimps along the beach. It becomes an assistant to the farmer when it goes off to the fields for a meal of insects. This bird is fairly evenly distributed along the coasts of Britain, especially where there are sand dunes or pebble beaches.

day, did not prevent the appalling question being asked—if twenty-five birds can consume this mountain of fish in a year, what of the birds round the entire British coast?

A similar agitation fermented for years on the East Coast, where it was demanded that, since terns had increased at Blakeney Point, in Norfolk, and the flat fish had decreased, these flying feys must die. Forty-eight were killed and sent up for stomach analysis to Dr. Collinge. Not a bone, not the tiniest fragment of flat fish was discovered in a single one. Yet before protection was accorded to terns and certain other sea-birds on our coasts, the coastal bird-homes resembled a bird-battlefield at the end of last century. Analyses of other fish-eating birds (nineteen species) were made, and it was found that only 45 per cent. of their food was piscine.

But the point of the story is that in 1883 Huxley had declared that all the principal food-fisheries—cod, mackerel, herring and others—were "inexhaustible," while later investigators have corroborated his verdict to the effect that "no action of man or bird can make any appreciable difference to the plenitude of fish," such is the overwhelming fecundity of the ocean. The irony is the more pointed from the fact that it has been the bird-accusers themselves who have been responsible for the excessive wastefulness of the fishing industry in the destruction of millions of useless young plaice by the trawlers. All the sea-bird battues, all the Reports, all the expenditure of money, argument and foolish greeds that made them boiled down to a vanity of nothingness from the simple fact that the sea provides and always will provide more than enough for all, men and birds and porpoises and dolphins and seals and sharks and dog-fishes alike.

It is, indeed, literally impossible to estimate the magnitude of the destruction in wild life, of the impoverishment of nature and of the losses to agriculture for which the acquisitive elements nurtured by the industrial revolution are responsible. It is not a very comforting thought that such losses might have been avoided if we had known nothing about nature at all, but if good feeling had taken the place of lack of knowledge. Injurious species of bird, that is to say, are in so small a minority that had they been protected together with the beneficial species purely out of sentiment, we should to-day have been materially the richer for it. In the light of such a fact it is odd that the illusion should persist that what are commonly called "sentimental considerations" are entirely impractical. On the other hand, the reiterated voices of the few urging us to observe

Oliver G. Pike

the poetic justice of that lack of sympathy which drove us to "conquer" nature at the price of so many disasters are nowadays beginning to be heard. In many different ways, our fatal interference with the slowly-perfected adjustments of nature has produced harmful repercussions. Not the least of them is the wilful creation of a mass of highly complicated problems which never existed before we tipped over the natural balances of wild life.

THE life of nature is an interwoven pattern of strands; break one and others come apart, and they in their turn introduce confusion into other sections of the wonderfully con-

Various blunderings through it, for instance, have caused a wholly disproportionate increase of that brisk little urchin, the house sparrow. In agricultural districts, 75 per cent. of the sparrow's food is cereals and only five per cent. injurious insects. He gorges on ripe crops; he usurps the nesting sites of more desirable species; he riots among the flowers, and his mobs have the same general effect on bird-life that the standardised herd-mind has upon human society. He depreciates the qualitative currency of bird-life. Yet it is impossible now to shrink his numbers to their natural balance with those of other species by artificial means. Even cats, which, according to the evidence, destroy something like fifty per cent. of our garden birds every year, do not sensibly diminish the sparrow hosts. On the other hand, we reduce birds like the corn-crake, that Samson among the insect cereal-devourers, to such scarcity that the species is near that margin of resistance when it, as it were, loses heart and fades automatically into extinction. Moreover, in order to redress this topsy-turvydom of common and uncommon species, we have elaborated a system of bird protection laws which nobody understands, nobody enforces, and nobody observes. Our birds are far better protected to-day than in those havocking Victorian days, not by the cumbrous machinery of the law, but by the steady growth and widening of a delight in their beauty, animation, and a kind of celestial quality they have about them.

Poetic justice has overtaken our prideful short-sightedness in another direction. The plagues of Egypt are always on the horizon; the rustle of their champing mouths might well drown even the din of our mechanical civilization. It has been estimated that the passerine birds of the eastern half of Nebraska destroy 162,771,000 locusts a day. The average locust weighs fifteen grains, and consumes its own weight of cereals every day. In a year this number would devour 174,397 tons of crops, worth nearly two million dollars. In the Abruzzi, locusts move in such earth-darkening swarms as occasionally to hold up the trains between Rome and Avezzano. An ornithologist has worked out that a pair of gipsy moths, if unchecked, would beget enough offspring in eight years to destroy the entire foliage of the United States. The chinch bug, a potato-glutton and a favourite food of the quail, can accommodate 20,000 of its numbers on

G. Hearn

YOUNG LAPWINGS AND THEIR PARENT

Any depression in the turf or on the plough will serve the lapwing for a nest, and the young, on hatching in a ploughed field, find themselves at once in the midst of a plentiful supply of grubs which are destroyers of crops. The lapwing's other name is peewit, in imitation of its cry.

eight inches of grass stalk. Or listen to this. If a hop aphis succeeded in developing thirteen generations in a single year, the brood, if marshalled in line, would extend to a point so remote in space that light, travelling at the rate of 186,000 miles per second, would take 2,500 years to reach the earth from the head of the procession.

It is not surprising, therefore, that the early settlers of Salt Lake City erected a monument to Franklin's Gull for clearing their wheatfields of the crickets that threatened them with starvation. One rookery of Australian straw-necked ibis (*Carphibis spinicollis*) was calculated to have digested 482,000,000 grasshoppers in one year.

M. H. Crawford

CORNCRAKE THAT PREYS ON SNAILS

Reaching England in April from its winter quarters in Africa the corncrake or landrail likes low-lying meadows, and places its nest in the standing hay or corn It preys on small snails and slugs and insects. When alarmed it sneaks from cover to cover along the ground, only taking wing in the last resort, when it flies clumsily.

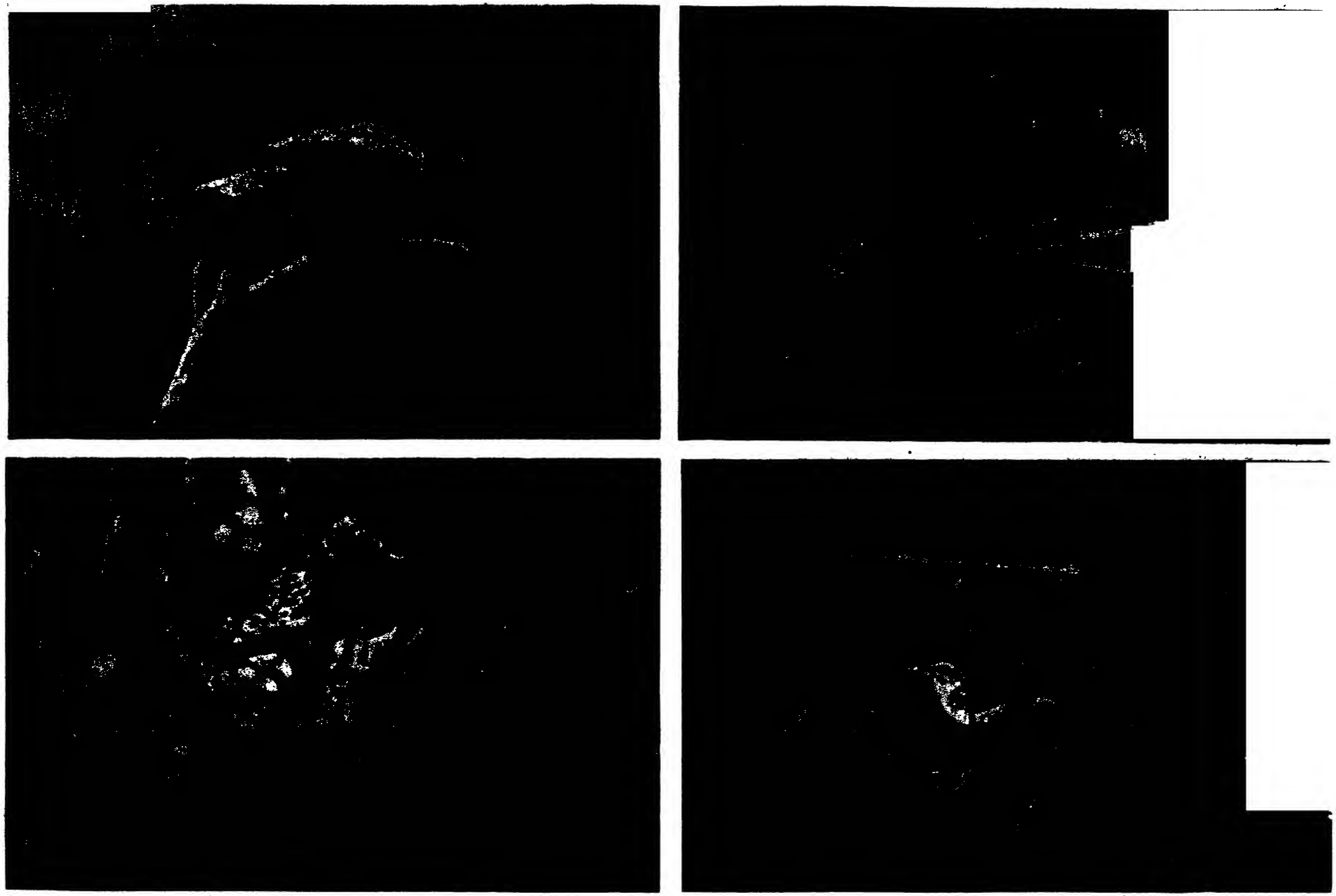
a few percentages of the insect food some of our more familar birds feed their nestlings on—starling 90 per cent., songthrush 86 per cent., blackbird 60 per cent., great tit 90 per cent., skylark, wren, yellowhammer, blue tit and chaffinch 100 per cent.: add to this the fact that the nestlings are fed at intervals of from a half to a full minute with a beakful from sunrise to sunset, and the statement that if the entire bird-stock of the world were to be annihilated, the earth would become totally barren of vegetation in three years will not appear very extravagant.

Of course, a certain proportion of the insects eaten by birds (the ichneumon fly, for instance) themselves prey upon the noxious members of the insect multitudes, and though it is highly immoral of them, birds do not discriminate between them. Man, too, invents ingenious artificial devices to check the invading hordes. But on an all-round view, a working knowledge of the inter-relations between birds, crops and insects shows that the practice of destroying the former on a large scale is one not of nature-conquerors but of lunatics. A swelling of the insect legions follows upon a diminution of bird-life as all effects follow upon their contingent causes.

Another ill-effect of crashing through the subtle architectural poises of nature is our habit of sticking moral labels on birds as a porter registers trunks to different destinations. We speak of "good" birds and "bad" birds when what we really mean is birds that live on different types of diet.

Actually there is an extremely simple way out of all the artificial complications of economic ornithology. Thanks to the researches of Dr. Collinge ("The Food of some British Wild Birds") and others, we know precisely how birds stand to the farmer and how the farmer should stand to birds. The "volumetric" method, that of averaging the total food of a given species in different districts and all the year round by examination of the crops of various individuals of it, clearly reveals that the great majority of species are beneficial to man. Seventy per cent of the food eaten by the lapwing, which agriculturists have allowed to become reduced so seriously from its former abundance, consists of the wireworms, leather-jackets, weevils, myriapods and coleoptera which live entirely upon the fruits of the field. The woodpeckers, shot for the damage to trees attributed to them, devour the ash, pine and bark weevils, the longicorns, leopard, clearwing and tortrix moths, which spend their larval stages in riddling timber which the birds themselves never touch except for the purpose of extracting these pests. Seventy-five per cent. of the total woodpecker food consists of these insects.

To this general rule that nearly all our British species do far more good than harm to our agriculture and fruit-growing there are eleven exceptions, which have to be differently graded. The rook and the starling are more injurious than beneficial in certain



G. Hearn

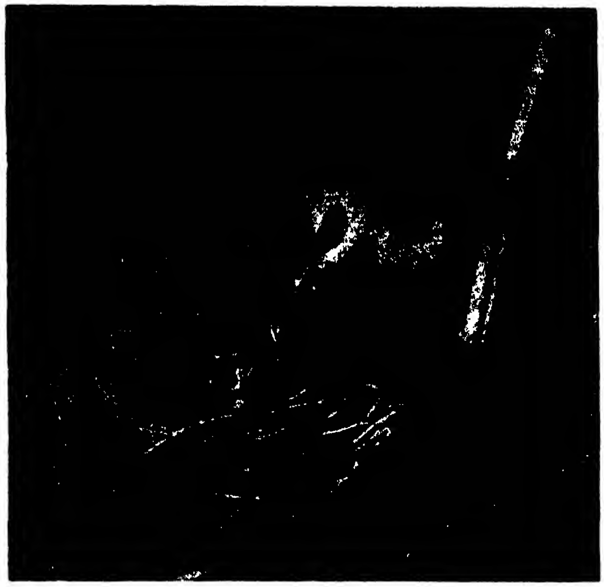
ALLIES IN THE INSECT WAR: THRUSH, SEDGE WARBLER, STARLING AND FLYCATCHER

Though the song thrush (bottom left) is a favourite because of its music, it is also to be commended for the slugs and grubs it consumes. It is nearly always found in cultivated places, such as gardens and orchards, and while it makes some havoc with fruit in the late summer, it more than compensates for the damage by the good work it puts in, ridding the land of pests during the rest of the year. The sedge warbler, which we see here (bottom right) building its nest, is found in marshes and by the banks of rivers, and is very partial to slugs besides the water insects and larvae. The starling (top left), where it is not over abundant, is a good insect destroyer, and the name of the flycatcher (top right) tells of that bird's most constant occupation.

areas, because our interferences with the web of natural life have increased their numbers out of all proportion to their natural rate of reproduction where the checks and balances of the wild are in operation. The house sparrow, the ring, stock and rock doves, and the bullfinch certainly do more harm than good to fruit, cereal and garden cultivation.

But the bullfinch and the rock dove are uncommon birds, and the aggregate harm they do is shrunk to a little measure by the paucity of their numbers. With the bullfinch, beautiful alike in his plumage, so English in its colouring; his music and his devotion to his mate, good feeling and love of beauty should have the last word. The sparrow hawk, blackbird, greenfinch and chaffinch are partially harmful.

The sparrow hawk accounts for rather too many insectivorous birds, though he reduces the numbers of sparrows and starlings. But he is not really a serious problem, partly because the gamekeepers wage such merciless war against this poor Ishmael, and partly because birds of prey only secure the weaker members of their natural food-birds and so help to preserve the vigour of the stock. The black one of the woodland Pan-pipes with "orange-tawny bill" devotes 25 per cent. of his total dietary to the fruits he is luckless enough to enjoy as much as we do. On the other hand, 22 per cent. of his yearly sum of meals consists of injurious insects. The chaffinch's bill of fare is 56 per cent. of weed seeds, 16 per cent. of injurious insects, 1 per cent. of beneficial insects, 4 per cent. of fruit buds, and 8 per cent. of cereals, so that it is difficult to assess which has the better of it—the cloud or the silver lining.



Oliver G. Pike

WHITETHROAT FEEDING ITS YOUNG

Whitethroats raise two broods each summer, and have to keep a number of widely gaping beaks satisfied. This means hard work and a tremendous toll of insect life. The nests of these small birds are virtually insect destroying factories

A. H. Willford

INSECTS BY THE BEAKFUL

Some idea of the number of insects demanded by the average family of long-tailed tits can be gathered by a glance at this photograph. The parents catch their food largely on the wing, and every few minutes one or other of the birds is at the nest.

Hence the reduction of the superabundant species has to be moderately and scientifically undertaken, while those which are not plentiful should be allowed to contribute their glow to the prism of life. To exterminate a species on any account whatever or reduce it to a perilous rarity is a crime unpardonable, and even with the house sparrow and the wood-pigeon, who do vastly more harm than all the other nine species put together and multiplied by ten, we owe it to the creative power of life and evolution (what used to be called "the glory of God") to depress their numbers humanely and courteously. The winter wood-pigeons have to be shot because they are immigrants, but the true method of reducing too abundant species and so restoring balances is to remove their eggs and diminish the available number of nesting sites.

Our legislation, which is usually a hundred years or more behind contemporary enlightenment, should follow suit by repealing all Protection laws at present in pseudo-force and passing a single comprehensive Act protecting the eggs and person of all wild species, excepting (I quote Dr. Collinge) "such as are known to be too numerous or injurious." This "black list" should be strictly subject to local conditions and to constant revision, while the nine, ten or eleven species on it should be safeguarded from indiscriminate, wanton or ill-judged destruction. If we were to carry out this simple measure, we could in time undo an imponderable amount of mischief both to nature and ourselves, enjoy our birds and our crops together, and hear a great deal less of that overdriven expression, "economic

BULL AND BEAR WHOSE STRENGTH HAS SO OFTEN BEEN USED FOR "SPORT"

To men the bull has always stood as a symbol of strength, and in the wild state an extra ferocity is added to the power of the great which operates the horns. Above is a bull from a herd of the English wild cattle which are still preserved in some parts of Britain. upper photograph shows two bears, and it will be remembered in this connection that two of the favourite old English sports were bul bear baiting, where these Samsons of the animal world were goaded by a Philistine crowd who set dogs on to attack these great beast

Chapter LIV

Samsons of the Animal World

By W. S. Berridge

Author of "Marvels of Natural History"

PHYSICAL fitness plays an important part in the lives of all living creatures, and the old adage that "the weakest go to the wall" is especially applicable to the members of the Animal World, for without health and strength they have little chance in the struggle for existence. The very term wild beast seems to suggest power, vigour, agility, and muscular development, and it is difficult to conceive a C3 grade of animals, to make use of a war-time expression.

But although there is no disputing the fact that some creatures are much stronger than others, such a difference is largely of a relative nature; for the tiny flea and the mighty elephant are both entitled to rank as Nature's Samsons.

Animals characterised by their large size are normally endowed with great strength, for they must necessarily possess large bones, to which are attached powerful muscles. Bulk, however, may to a certain extent be due to obesity, especially among those animals, such as the bears, that hibernate and accumulate a store of fat upon their persons prior to their winter sleep. But such a condition is only temporary, for when the time arrives for the creatures once again to lead an active life, they have absorbed into their systems all their superfluous fat, and come forth from their lairs both lean and very hungry.

The bulkiest of animals, though not the largest, is the hippopotamus, a creature that sometimes attains a length of fifteen feet (inclusive of the short tail), and a weight of four tons. Its barrel-shaped body is supported by stout, short legs, and the massive head is set upon a thick neck. The mouth is enormous, and instances have been recorded of the hippopotamus upsetting and crushing a native canoe between its jaws. It has been known even to ram a river steamer, and one writer mentions a individual that chased and overtook a man on dr land, and then bit him in half.

As a rule, however, the hippopotamus leads somewhat sedentary life, and spends much tim basking and dozing upon the mud-flats; but shoul it be disturbed, it rushes into deep water, and make such a splash that one might almost imagine a tid wave had arisen.

Another animal giant is the elephant. Found i Africa and Asia, an individual from the forme Continent has been known to measure eleven fee eight and a half inches in height, and one from th latter region ten and a half feet. Such measurements however, are unusual, and a stature of between nin and ten feet may be regarded as the average.

Although the skull of an elephant is very large, is not so solid as it appears, the interior of the bone being honeycombed with cells separated from on another by thin partitions. The incisor teeth ar developed into tusks that may protrude beyond th lips for a considerable distance. It is recorded tha a pair of tusks of a African elephant weighe as much as 293 pounds and measured respec tively eleven and a ha and eleven feet in length

Needless to say, th combined weight of th elephant's skull an tusks could only be sup ported by a short thic neck, and as a shor neck would not allo the animal to reach th ground with its mout for the purpose c picking anything u Nature has endowed with a wonderful orga known as the trunk c proboscis—an elongatio of the nose, pierced b two tubes or nostri surrounded by a grea mass of muscles.

Elephants will ofte uproot trees in ord to feed upon the folia of the upper branches the leaves of the mimos being regarded as special dainty. Trees c thirty feet in heigh

BEISA ORYX OF AFRICA

Among the most powerful of antelopes is the beisa oryx, which lives in British East Africa and Abyssinia. The horns are long and only slightly curved and are tremendously formidable, the upward double-pointed thrust being delivered with great power.

following unhappy incident shows. An Irish soldier, stationed in India, thought he would test his rifle upon a captive rhinoceros. Taking careful aim, he pulled the trigger, and to his astonishment the beast promptly fell down dead. His faith in the toughness of the beast's hide received a rude shock, and the compensation he afterwards had to pay left him a poorer but certainly a wiser man.

In spite of its great bulk, the rhinoceros can run with considerable speed. When charging, the animal rushes blindly forward with head lowered ready to thrust its horns into the body of its foe. Even full-grown elephants have been known to be killed as a result of an encounter with one of these enraged beasts, so dangerous are they even to other powerful creatures.

with stems four and a half feet in circumference, are brought toppling to the ground, several animals sometimes combining in the task, some employing their trunks for pulling, while others will dig at the roots with their tusks.

The great strength of the elephant is made use of to a large extent for lifting and stacking logs in the timber yards of Ceylon and elsewhere, while in the olden days the creatures were employed in warfare, and also for fighting in the Roman arena.

Very formidable beasts are the rhinoceroses, for in addition to their great bulk, they are armed with one or more upstanding horns, situated upon their snouts. In the Indian rhinoceros, which has been known to measure eight feet in length (exclusive of the tail), only one of these weapons is present, but the common African rhinoceros normally possesses two, and individuals with three have been recorded.

The horns have no connection with the skull, and are merely composed of closely-packed fibrous hair. Moreover, they are slightly mobile, inasmuch as they will yield to pressure. According to an early writer, the foremost horn of the two-horned rhinoceros is plastic and hangs limp like the trunk of an elephant. Only when the beast is enraged does it become erected into an implement of offence. Unfortunately, however, this story is not true.

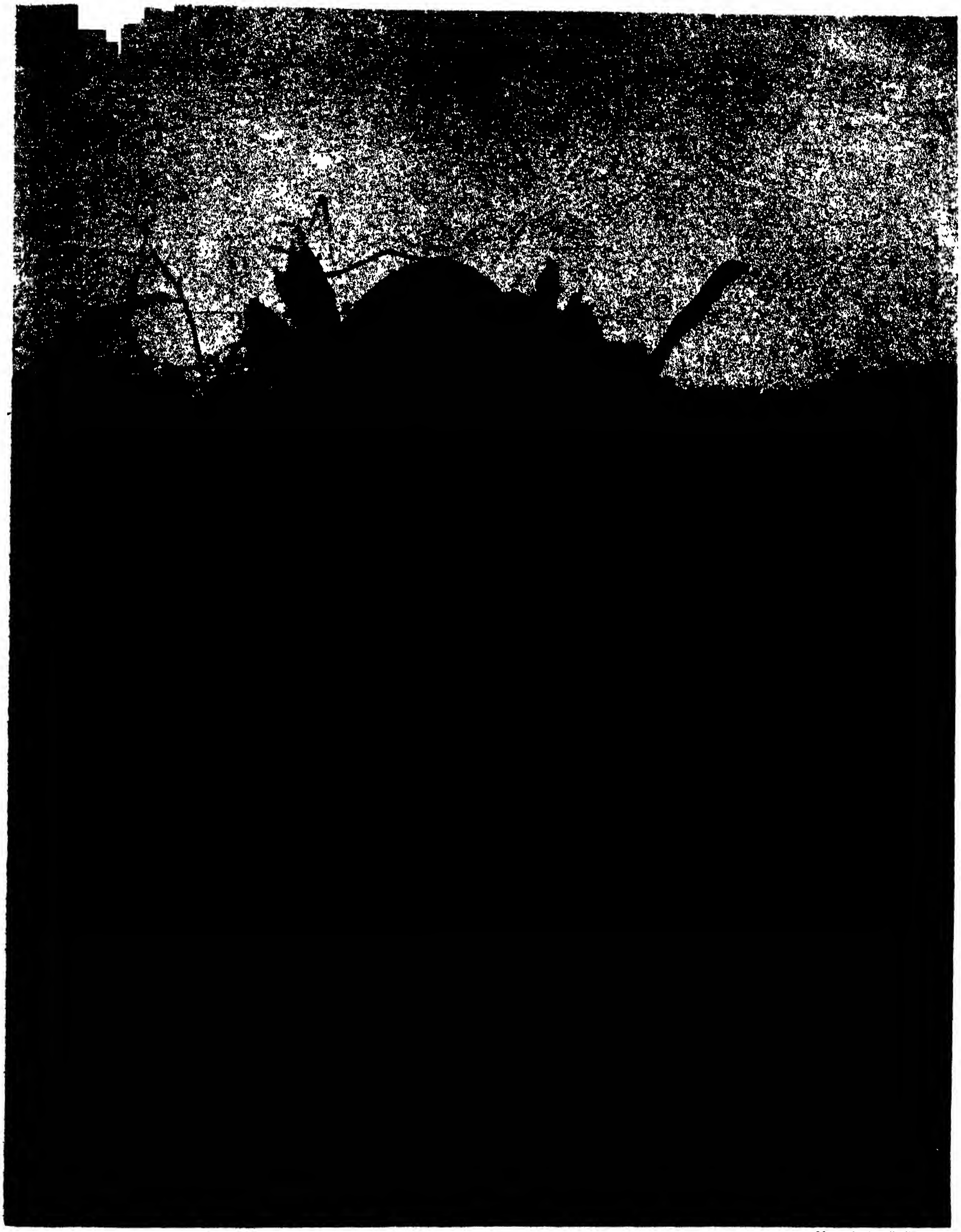
It has often been stated that the skin of a rhinoceros is bullet-proof, but such is not the case, as the

W. S. Berridge

DANGEROUS WEAPONS OF THE ANTELOPES

These horns of the sable antelope (top) are used with the greatest dexterity and, wielded by powerful neck muscles, can deal with several dogs at a time. It has the trick of a sideways jerk of the head which will transfix anything attacking from behind. Below is a sabre-horned antelope.

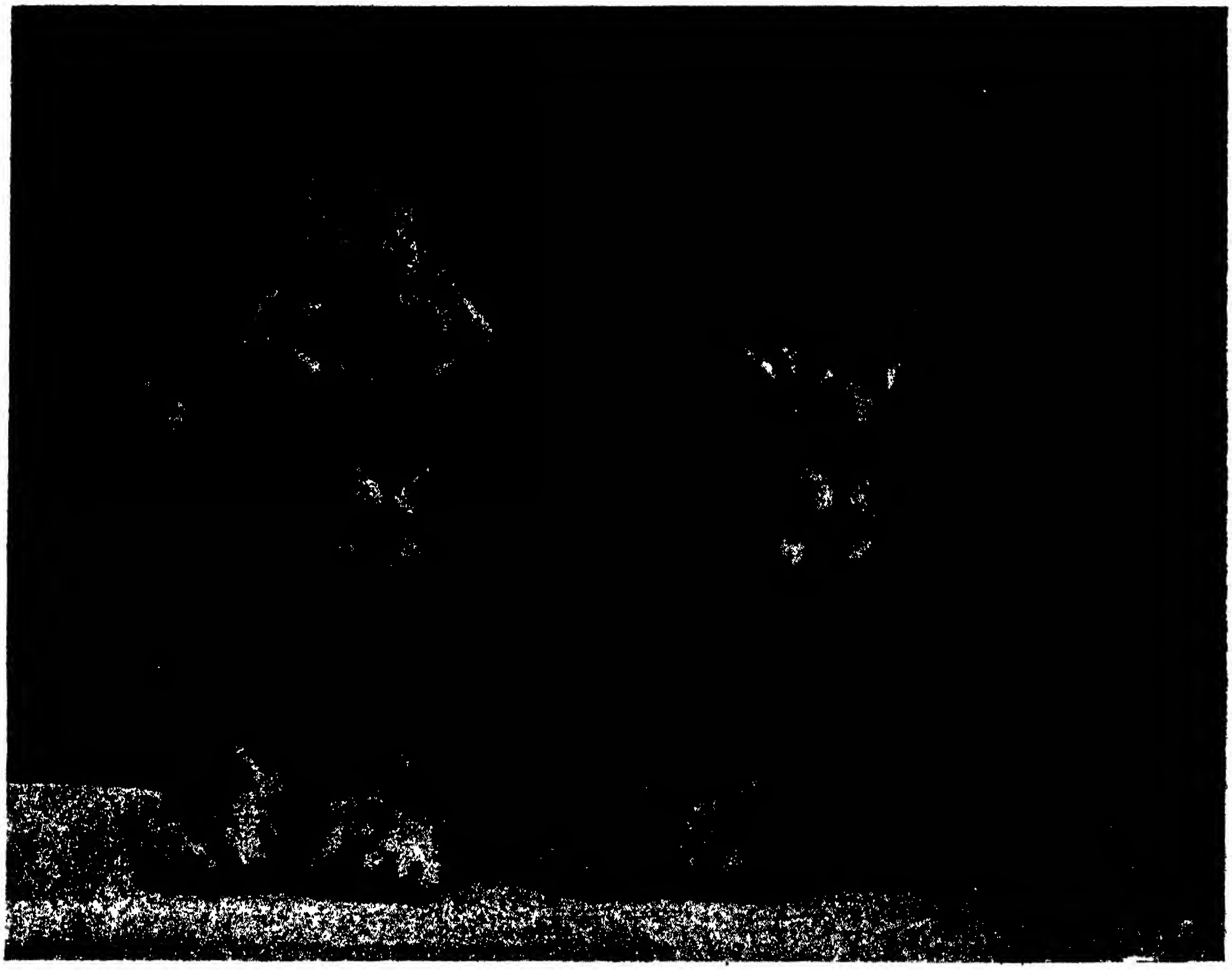
The possession of horns s common to other animals, such as oxen, sheep, goats, antelopes, and deer. Those of the latter, rightly called antlers, differ from those of other ungulates, inasmuch as they are solid, and are shed at intervals, instead of being composed of hollow sheaths, supported by a bony core, and retained throughout life.



Major Radclyffe Dugmore

A WRATHFUL SAMSON: RHINOCEROS ABOUT TO CHARGE

Not only is the rhinoceros enormously heavy, but it is also a quick mover when anger or fear is the incentive. Its charge is irresistible for any living thing, for there are several tons of weight behind the drive of the great horns on its snout. This specimen is from Africa,and has two horns, whereas the Indian rhinoceros has only one. Notice the typical attitude that denotes danger, the ears pricked and the tail erect, making a picture of indignation. There is, however, one great safeguard. This Samson is not blind, but he is very short-sighted.



STRENGTH IN REPOSE FACES THE CAMERA

With one blow of its paw a lion can kill an ox, and it is on these terrific blows rather than on its fangs, which usually attract more popular attention that the lion relies. A lion has been known to leap a wall nine feet high while carrying a calf in its mouth; and the possession of the power for such a leap easily constitutes the animal a "Samson." Even when taking its ease the lion gives an impression of self-confident strength, and if the animal yawns and stretches itself the great muscles can be seen moving under the skin.

The largest of the wild oxen is the gaur, a creature that may stand as much as six and a half feet at the shoulder; while of somewhat smaller stature is the Cape buffalo, a beast that has the reputation for being the most dangerous and fiercest of African animals. Both of these Samsons possess very massive horns, those of the latter being extremely broad at the base, and meeting across the forehead so as to form a cuirass that no bullet can penetrate. The strength of these huge cattle can well be judged by stating that some at the London Zoo have bent the thick iron bars of their cages with their horns to such an extent that large pieces of stout timber have had to be clamped crosswise thereto, so as to prevent further damage.

Among the antelopes, certain species stand out as being Samsons of their kind, the beisa oryx, the sabre-horned antelope, the gemsbok, and the sable antelope being notable examples. Endowed with great strength, and possessing long, backward-sweeping horns, they can render a good account of themselves if brought to bay, and instances have been recorded of lions being killed in combat with these courageous and graceful creatures.

Even the normally placid sheep do not always live up to their reputation. Indeed, the Indian fighting sheep or hunia (a domestic breed), is of such a pugnacious disposition that it is reared and kept for the sole purpose of affording sport, two of the animals being pitted against each another in combat. They fight with their heads, rushing at each another from a distance of about ten or twelve yards, and meeting with a crash that would split the skulls of most creatures. Sheep, however, are notoriously thick-skulled, and such blows do not appear to give them even a headache, for no sooner has the first one been delivered than they walk backwards to their stations and prepare for the next round. But even the strength of the mightiest has its limits, and in time the battle must end either in a draw or a "knock-out." On one occasion a fighting-ram was pitted against a tiger, the former attacking with such

determination that a well-placed blow in the ribs caused the downfall of the giant cat.

The lion must also be mentioned among the Samsons of the animal world, for has he not earned the title of "the king of beasts"? Endowed with great muscular power, and having jaws armed with a formidable array of teeth, he is a creature that can command respect. He can fell an ox, an antelope, or a zebra with a single blow of his paw, and has even been known to leap over a wall, nine feet high, with a newly killed calf in his mouth.

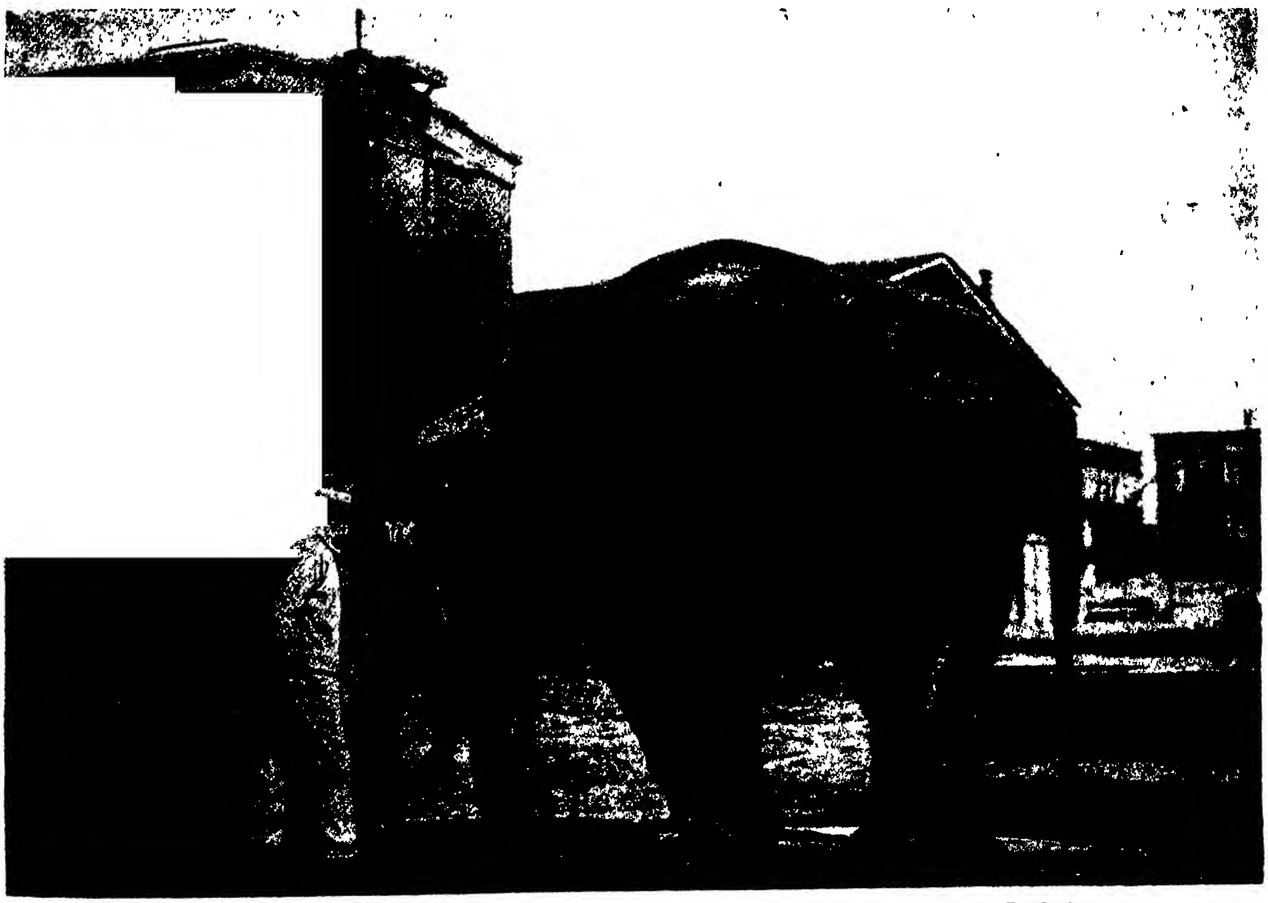
As a rule, lions do not molest human beings, although occasionally individuals will turn man-eaters. Curiously enough, these are invariably old animals that have become too decrepit to overpower their normal prey, and have learned that an unarmed native falls an easy victim to their attack.

At the Zoo the lions are always sure of having an appreciative audience. But natural history is not always a strong point with visitors, and a man was once heard to exclaim to his companions who were gazing at a very fine specimen, "Fancy him being able to kill a man with a blow from his tail." It is true that a lion's tail has a small thorn-like growth at the extremity, hidden beneath a tuft of hair and that at one time it was supposed that the beast employed this to lash his body and goad himself into a state of fury. These picturesque conceptions, however, are not based upon fact, and the tail can in no way be regarded as a weapon.

As in the case of the elephant, lions were often engaged in the animal fights that the Romans used to organize for the amusement of the public, and we also read that it was an ancient custom in the East for offenders against the law to be cast into a den of these animals.

But the lion is not the only creature that has been employed in the rôle of executioner, for, according to an old account, the gorilla has been utilised for that purpose, the huge ape tearing to pieces the unfortunate malefactors that were thrown to it. It has also been stated that gorillas will carry off natives and overcome the elephant in combat.

"They goe many together," to quote the words of Battel, "and kill many negroes that travaile in the woods. Many times they fall upon elephants which come to feed where they may be, and so beat them



AN ELEPHANT'S GREAT STRENGTH UTILISED TO PUSH A FREIGHT CAR

A very massive head armed with weighty tusks such as the elephant has must be supported on an enormously powerful neck. The pushing power of such a head and neck with the weight of an elephant's body behind it can be imagined. Here is an elephant being used in the U.S.A. for shunting a heavy freight car. Notice the position of the head and the attitude of the great forelegs, suggesting mighty effort. As for the strength of elephants it may be mentioned that these animals have a short way with a tree whose foliage is out of reach. They uproot it.

RAM'S POWERFUL HEAD ARMED WITH TWICE CURVED HORNS

The name of that once most effective weapon of siege war, the battering-ram, was a compliment to the strength with which the male sheep attacks its foes. One still speaks of warships "ramming" each other, but this form of attack, which is often almost as disastrous to the attacker as the attacked, is undertaken lightly by the animal which will charge and charge again against the equally hard and forceful head of a rival. In addition to the strength of the neck and the hardness of the skull, the ram possesses these twice curved horns

with their clubbed fists and pieces of wood that they will runne roaring away from them. These pongos are never taken alive, because they are so strong that ten men cannot hold one of them."

Although too much reliance must not be placed upon these early stories, the fact remains that the gorilla is one of the most powerful creatures that populate the earth. The great breadth of its chest at once proclaims it to be endowed with exceptional strength, while its arms are of enormous length, and its hands at least a third larger than those possessed by a human being.

Another of the manlike apes famed for its strength is the orang-utan, or mais, as it is called by the natives. With the exception of the crocodile and the python, no creature dare attack this Simian Samson, and even such encounters as may occur may be regarded more as accidents than otherwise, and the reptiles usually pay the penalty with their lives.

When dealing with a crocodile, the orang-utan pulls apart the reptile's jaws with his hands and then rips up its throat with its teeth; while the python, despite its strength, is also seized in the ape's terrible grasp, and then bitten so severely that it quickly succumbs to its injuries.

The great power in the hands and fingers of the orang-utan was revealed by an incident that occurred some years back at the London Zoological Gardens. After the keepers had departed, one of these apes amused itself by picking away at the stout wire-netting in front of its cage. Soon it managed to break a piece in half, and then it was a comparatively simple matter to enlarge the hole thus commenced. The next morning workmen were sent to replace the broken wire, and although the ape had succeeded in bending and breaking it with its fingers alone, the human artizans were unable to make an impression upon the metal without the use of a cold chisel and a heavy hammer.

Of the smaller type of monkeys, the baboons possess great muscular power, as well as canine teeth almost as large as those of a lion. They fight freely amongst themselves, and have been known to attack man. As they congregate in troops, they are unpleasant customers to meet, although it must be stated that nowadays they have learned to realize the significance of firearms. But should an enraged baboon get at close quarters there is little chance of escaping serious injury, for it buries its teeth in its victim, and, without for one moment releasing its grasp, tears right through the flesh.

Although baboons are so powerful, they are by no means untameable if captured young. That they can be taught to perform manual labour was exemplified some time back by a chacma baboon which had been trained by a cripple railwayman who worked on a branch line in Africa. At the word

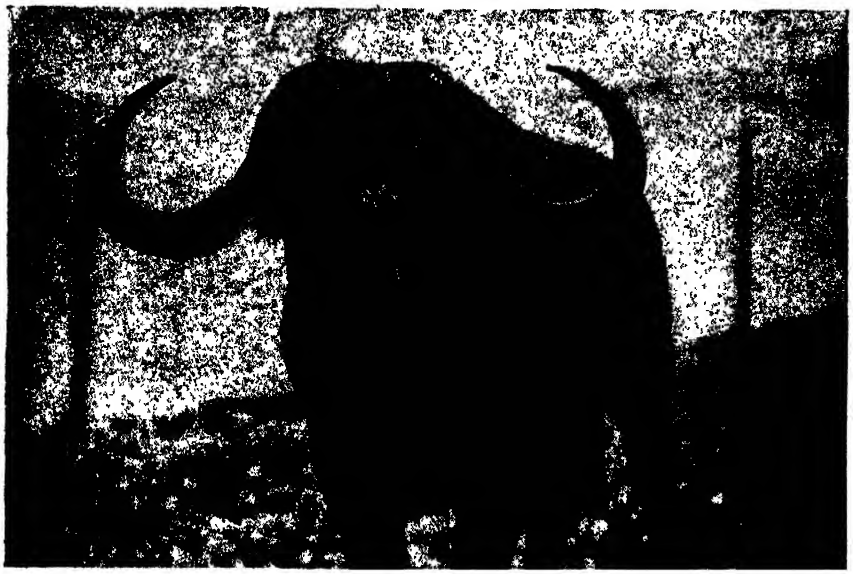
of command the animal would pull the heavy levers that worked the signals, he would pump up water from a well near by, and even push along the lines the trolley upon which his master travelled to and from his work.

The ugliest, and possibly the most powerful, of all baboons is the mandrill, a creature that always causes merriment to the beholder because of the bright red and blue tints that decorate the face of the males, and more especially so on account of the colour scheme revealed when he stands back to his audience. Found in West Africa, the natives hold the beast in great dread, and state that sometimes it will attempt to carry off women and children. Although such stories are probably much exaggerated, and it is more than doubtful whether the baboon could drag along an adult human being, there is no disputing the fact that it is endowed with comparatively enormous strength.

W. S. Berridge

NEPALESE FIGHTING RAM AND A DUEL OF CYPRIAN SHEEP

Fighting rams have long been kept in India just as fighting cocks and dogs used to be kept in England. From a distance of about ten yards the rams rush at each other with all the gallant fury of two knights at a jousting, and meet with such a crash that one would think no skull could stand. The upper photograph shows a fight between wild sheep from Cyprus.



W. S Berridge

Other denizens of the sea that claim our attention are the octopods and squids. Their enormous muscular arms are provided with numerous adhesive disks, and woe betide a victim that should be so unfortunate as to get within their grasp.

The octopus, as implied by its name, possesses eight arms, each of which is furnished with about 120 pairs of suckers, arranged in two rows. When these suckers are applied to an object the interior part is first of all raised, and then retracted, a vacuum of great tenacity thereby being formed. Many very sensational stories

Of the marine animals renowned for their muscular development, first place must be given to the whales, the largest of which may attain a length of as much as 95 feet. The naturalists of early days classified the whales as fish, and even at the present day there are many people who still consider them as such. But, although fish-like in form, they are mammals, breathing atmospheric air by means of lungs, and the females suckling their young.

WHALES propel themselves through the water by lateral movements of their tails,

Neville Kingston

POWER OF THE

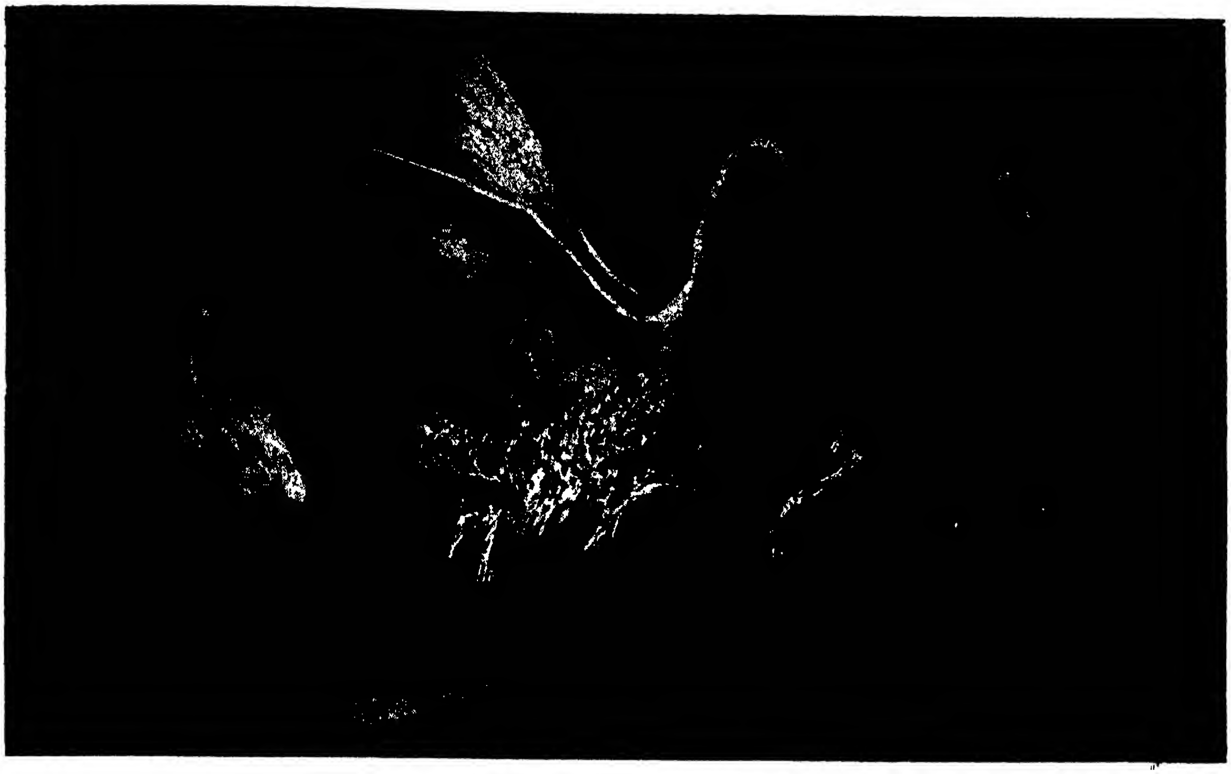
Strength, in the kangaroo's case, lies in the hind limbs, and it is these which the animal chiefly uses in its defence. The most terrible kicks can be inflicted, especially as the feet are armed with formidable toes which are capable of ripping up the body of a foe. Above is an East African buffalo which has a most powerful head and neck and a broad and massive pair of horns.

sions called flukes. When they rush off at terrific speed, and an instance is recorded of a blue whale, or Sibbald's rorqual, towing a steamer by the harpoon rope for 24 hours on end, notwithstanding the fact that the boat's engines were reversed in an endeavour to stop the leviathan's progress. On another occasion an individual plunged downwards in the sea to a depth of a mile, and then broke its upper jaw by the impact upon the bed of the ocean. Whales have been known to descend nearly five thousand feet below the surface of the sea, and at that depth the water exerts a pressure of about 140 tons on every square foot of their bodies. The greatest depth to which a human diver, equipped with modern appliances, can descend is stated to be about two hundred feet, but such a feat would certainly not be unaccompanied with the risk of paralysis.

have been recorded about the octopus, and enormous individuals have been described that could have existed only in the imaginations of the writers, but it is safe to say that specimens with tentacles six feet in length occur, though such a measurement may be regarded as a maximum.

Some of the squids, however, do attain to an immense size. Mr. A. E. Verril gives a description of a stranded squid in which the body measured ten feet in length, each of its two long tentacles (not possessed by an octopus) 42 feet, and its eight shorter arms, six feet.

Needless to say, one of these giants would be most unpleasant to meet at close quarters, and for a victim to be enfolded in its clinging tentacles and to feel the



suckers attaching themselves one by one with an unrelaxing grip, must be a terrible experience. The more the captive struggles the more it is encircled within the squid's awful embrace, and slowly the victim is drawn towards its mouth, armed with a parrot-like beak.

Suctorial power is developed to a very high degree in the limpets. They excavate shallow depressions, or "scars" on the face of rocks, always returning thereto, and settling down on their chosen spots after their journeys in search of food. Those of us who have endeavoured to remove one of these molluscs from its citadel will know from experience what force it is necessary to employ before the animal can be induced to release its hold. "So firmly do they adhere," says Dr. Riley, "that it is estimated that they exert a resistance capable of lifting 62 pounds, or about 1,900 times their own weight."

G. Hearn

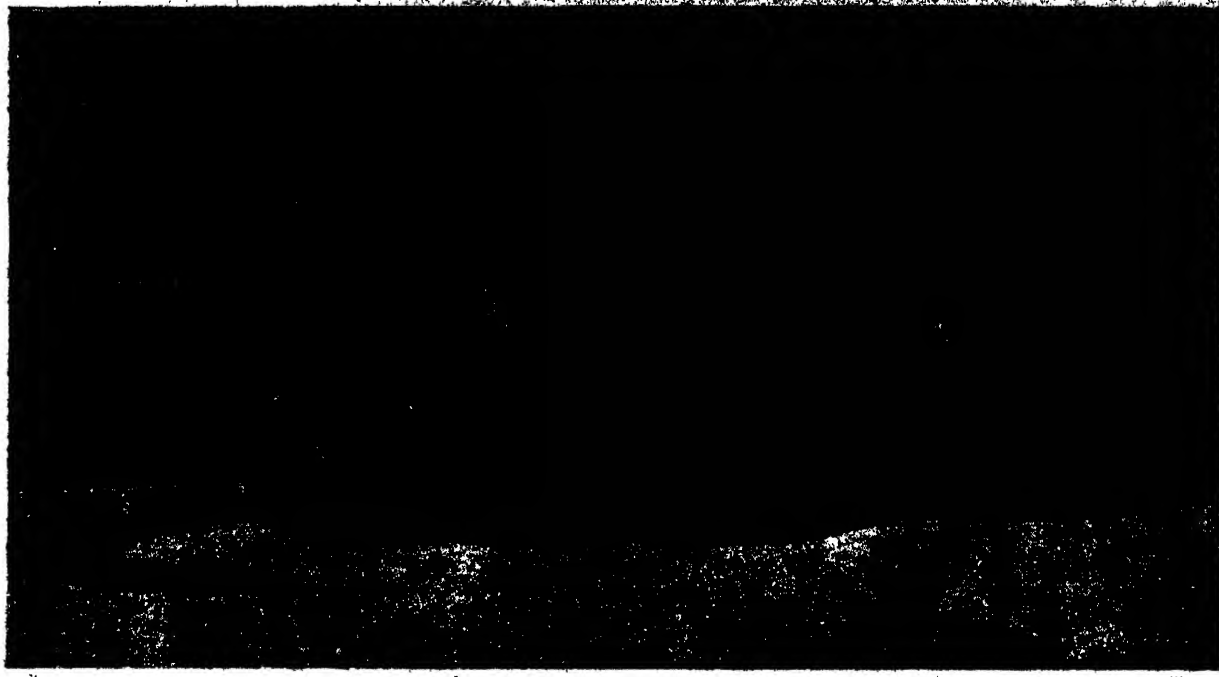
STRENGTH IN THE SWAN'S WHITE WING

Anyone who has seen the deadly battles which swans wage (bottom) will be readily convinced of their great strength. In fact, these are among the most truculent of birds, and the wings can break a man's arm at a blow. These birds often fight to the death and are sometimes very fierce when disturbed (top).

The oyster is another example of a shellfish endowed with great strength, for by contracting certain powerful muscles it can hold together the two valves of its shell with remarkable tenacity.

The giant clam also exhibits its power in a similar manner, but as the largest specimens may weigh as much as two thousand pounds, or nearly a ton, it is of a much more formidable nature. Men wading or diving in search of pearls have lost their lives through accidentally placing a foot between the open valves of this giant shellfish, and once within the clam's grasp there is no escape unless a companion should happen to come to the rescue with some powerful lever with which to prise the shells apart.

Mention must be made of the coconut, or robber, crab, a giant of its kind that often measures a foot in length. According to report it is able to break a man's arm, or crack the shell of a coconut, with a nip from its powerful, pincer-like foreclaws, and Darwin records that a specimen secured in a strong tin box actually made holes right through the metal, and also



Neville Kingston

DEADLY STRENGTH OF THE BOA CONSTRICTOR IN OPERATION

One sudden, deadly contraction of a large boa constrictor's coils can crush a man's ribs in a dozen places, and mammals the size of deer are killed in this way. In addition, the boa can use the strike like a poisonous snake, save that the hammer-like blow of the head takes the place of the poison fangs. A big boa can thus deliver what is probably the most powerful punch in the animal world. Above is one of these creatures engaged in crushing an animal preparatory to swallowing it.

bent down the edges of its prison so that it escaped. One of these crabs exhibited a short time back at the London Zoo would crack the shells of Brazil nuts, a feat that most of us find none too easy to accomplish even with the aid of nutcrackers.

The strength of some animals is displayed in their jumping powers, the kangaroo being a notable example among the higher creatures, and the flea being numbered among the more lowly forms.

Many of us have probably at some time or other had experience of the elusive nature of the flea. It can leap two hundred times its own length, and it has been stated that if a human being, six feet in height, was endowed with proportional strength, he would be able to jump to a height of two hundred feet, or in four consecutive bounds cover a distance of a mile. One writer likens the performance of a flea to a man leaping from Bow Church, in Cheapside, over the top of St. Paul's Cathedral, and landing at Ludgate Circus, but this is probably an exaggeration. The strength of the insect has been exploited by man in a somewhat curious manner, for troops of performing fleas have been exhibited from time to time, the liliputian actors being harnessed to small wheeled-carts, made of cardboard, which they pulled along in a somewhat jerky fashion.

The kangaroo also rivals the human athlete in its jumping power, the larger species sometimes covering a distance of about ten yards at every bound, and keeping this up for as much as eighteen miles without stopping. If brought to bay the animal proves a very formidable antagonist, striking at its enemies with forward sweeps of its hind feet, and endeavouring to rip up their bodies with its large toes. The forearms are to a lesser extent also employed for offensive purposes, and many instances have been recorded of dogs being seized within their grasp and then held under water until drowned.

Passing to the birds, we find that although the majority are built on somewhat slender lines, and can by no stretch of imagination be regarded as Samsons, certain kinds prove an exception to the rule.

Some birds are endowed with exceptional muscular power of the wings, others demonstrate their strength by the use of their talons, while others are remarkable for the development of their legs. Although the wings are primarily intended as organs of flight, not infrequently they are employed as weapons, and so great is the force delivered by a blow from the wing of a swan that men's arms have been known to be broken thereby. Spurs are present upon the wings of some birds, and also upon the legs, such weapons being capable of inflicting serious wounds. No less formidable are the talons of the eagles and vultures, and some years back an official at the Zoo was badly injured by one of the former birds that suddenly pounced upon him unawares.

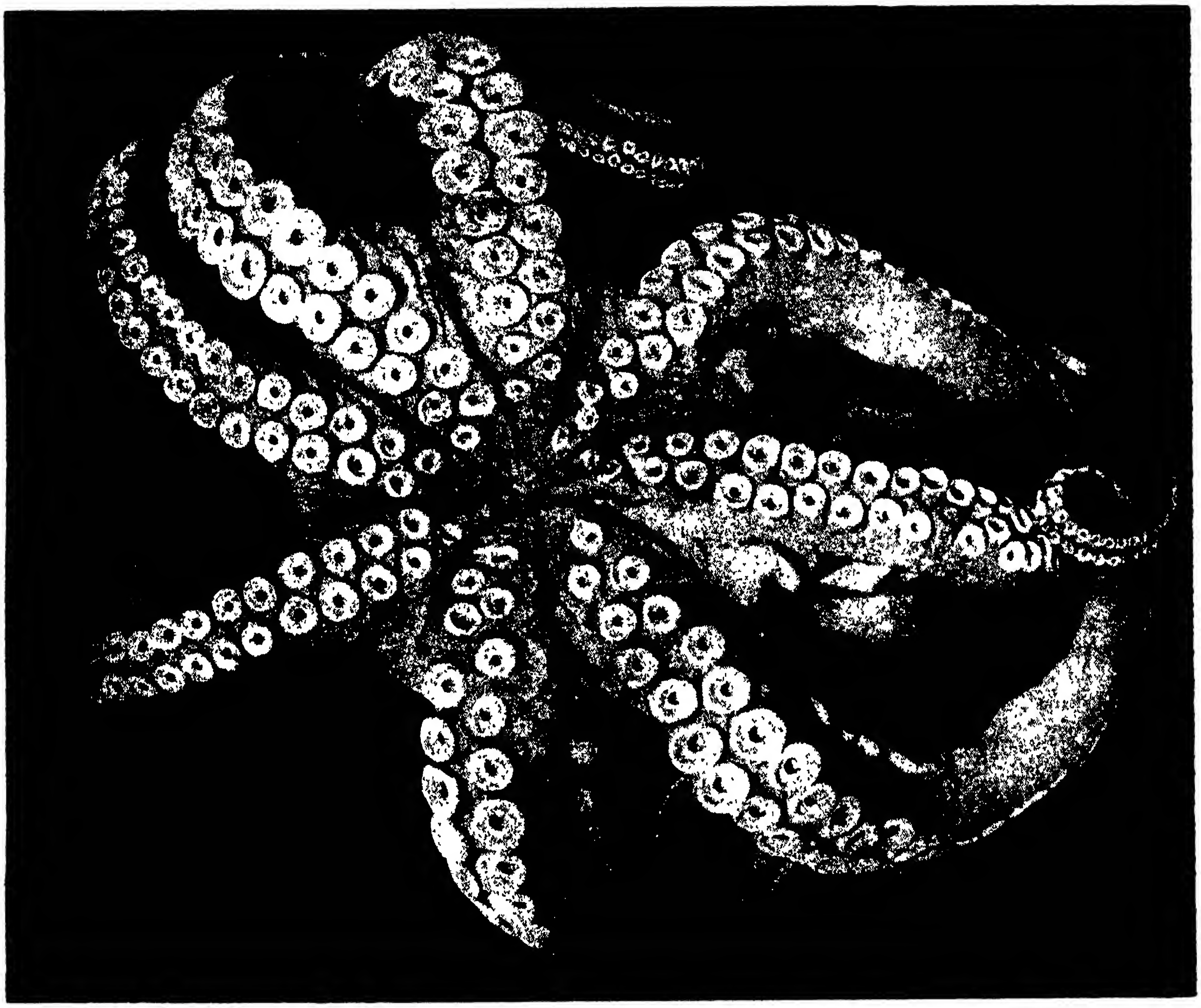
But the most powerful of all birds are the ostriches, the cassowaries, the emus and the rheas. These avian giants cannot fly, but they make up for their lack of ability in such respect by running with great speed. They possess very long legs, and their strong toes are utilised as weapons. Not all of these birds

A SAMSON AMONG ANIMALS. THE TIGER IN ITS FIERCE STRENGTH

Neville Kingston

LAND CRAB FROM WEST AFRICA AND ITS HUGE CLAW

As they grow old the male land crabs develop enormous claws powerful enough, it is said, to crack a man's arm. The specimen seen above is from the London Zoological Gardens, and is seen dealing with its dinner. In the upper photograph it has caught a mouse and is holding it up in triumph, while below we see the mouse, limp and dead, being conveyed to the crab's mouth. This particular crab came from Gambia, West Africa, where these creatures are abundant in the coastal parts.



however, attack in the same manner, for the emu delivers its blows in a forward direction, and the others strike out backwards and sideways.

The secretary-bird also uses its feet as weapons, stamping upon the snakes upon which it largely feeds, and reducing their bodies to a pulp. The force that the bird puts into its blows is astonishing, and the foot comes down with a thud that one would imagine would break the bird's leg.

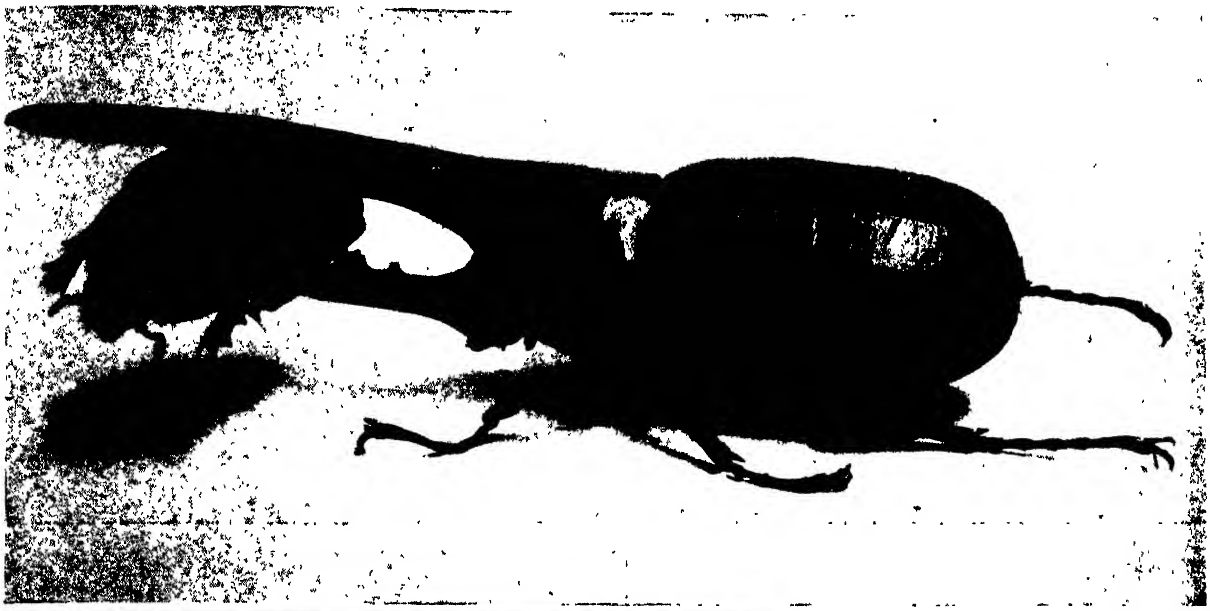
Possibly the most terrible exponents of strength are the large pythons and boas, reptiles that smother their prey with their coils, and by sheer muscular pressure squeeze and crush them to death.

The largest is the South American water-boa, or anaconda as it is more usually

W. S. Berridge

RELENTLESS SUCKING ARMS OF OCTOPUS AND SQUID

These horrors of the sea are Samsons indeed, with their powerful arms covered with suckers which each exert a powerful vacuum. The squid (bottom) has two long arms, and eight shorter ones, and a specimen which possessed these two large tentacles forty-two feet long, has been found and measured. The octopus probably does not grow arms longer than six feet.



Harold Bastin

GIANT TORTOISE AND HERCULES BEETLES

Here (bottom) is one of the giant tortoises of Galapagos weighing 350 pounds with a 3½ ounce tortoise on its head by way of contrast. Above is the Hercules beetle of tropical America. The male has the remarkable habit of carrying its female about with it between its enormous pincers. The Hercules beetle belongs to the genus Dynastes.

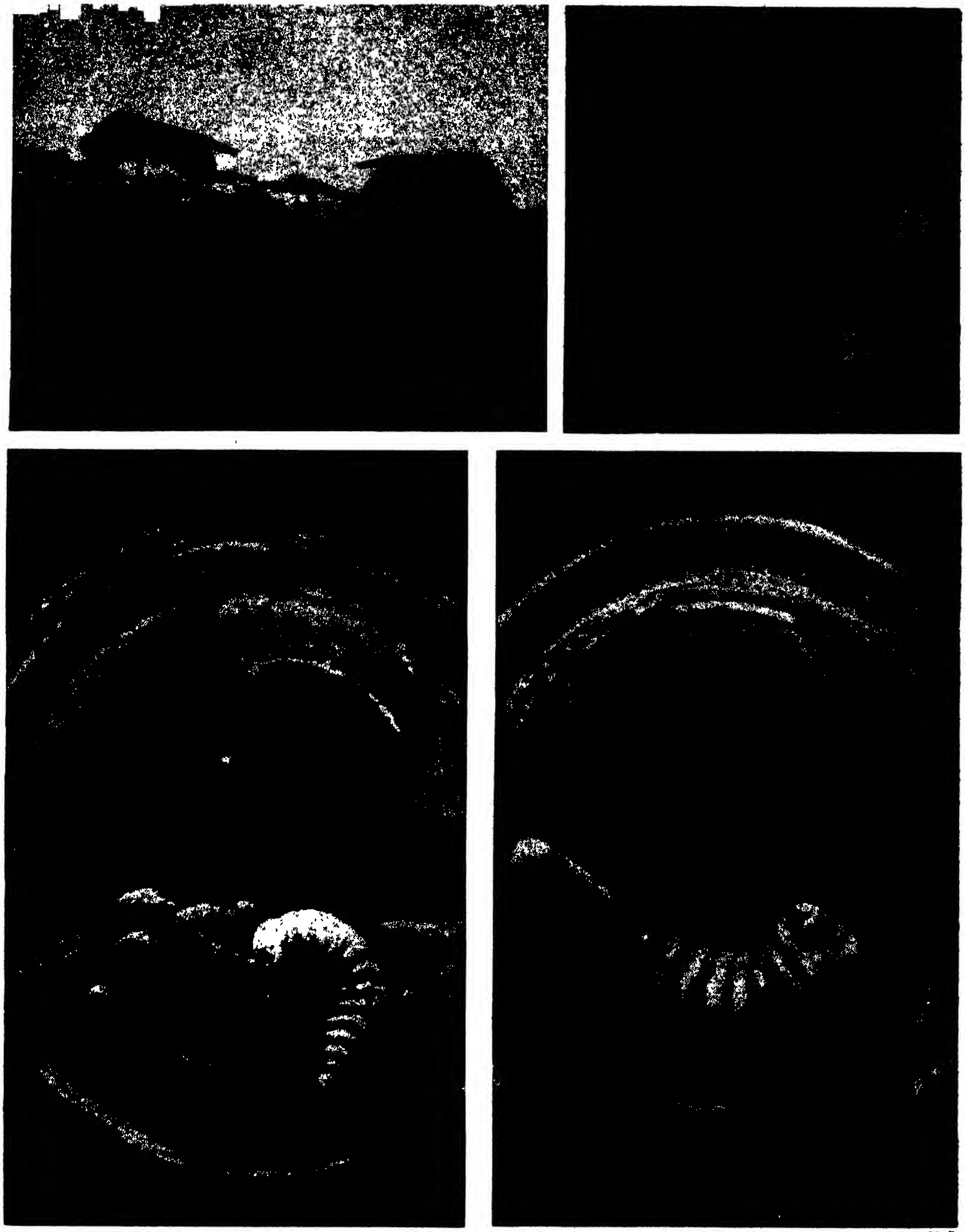
called. By the Spanish settlers it is known as the matatoro, a name meaning "bull killer," and they say that it grows to a length of eighty feet. Such a statement, however, is a gross over-estimate, and competent authorities are agreed that a length of thirty feet may be regarded as the maximum.

The reticulated python of the Malay regions, when full grown, is little inferior in size to the anaconda, and the Indian, or black python does not exceed 25 feet in length; while other large constricting snakes are the Australian diamond python and the South American boa constrictor, the latter seldom exceeding fourteen feet in length.

Numerous stories have been related of the great strength and swallowing capacity of these enormous serpents, but many of them are the outcome of a vivid imagination and are not based upon fact. In one old Natural History book, for instance, an account is given of a fight between a boa constrictor and a buffalo. The snake encircled the quadruped with its coils and, to quote the words of the narrator, "at every twist the bones of the buffalo were heard to crack almost as loud as the report of a gun," while as a fitting sequel to this astonishing yarn we are told that the beast was swallowed whole by the snake.

As a matter of fact constricting snakes do not crush the bones of their prey, and although they can swallow objects of much greater size than the girth of their own bodies, yet such creatures as wild pigs, antelopes or small deer are the bulkiest fare they can negotiate.

Although we have endeavoured in this article to cover as wide a field as possible our subject is one that could well be extended, the strength of the ant, the power of various big fish, the great muscular development of the forelimbs of the ant-eaters and the aard vark, and the wonderful manner in which some creatures will suspend their entire weight by their prehensile tails being a few other illustrations of remarkable physical development attained by animals that might well be included in our survey did space permit. It is clear that there are Samsons in all spheres of animal life.



J. J. Ward

INSIDIOUS PARASITE WASP THAT PREYS ON THE MUD WASPS

As an illustration of the law of "eat or be eaten" the case of the so-called cuckoo wasp is striking. This wasp seeks out (top photos) the already built nest of a mud wasp and lays an egg within. The cuckoo grub (bottom left) hatches first, and proceeds to feed on the mud wasp grub. Nine days later (bottom right) it has finished the store of caterpillars as well. But it sometimes happens that ichneumon flies have already laid their eggs in the caterpillars. The ichneumons hatch first, and deal with both wasp and cuckoo grub. The photographs illustrating this chapter were taken over a long period by Mr. J. J. Ward who has made a long and patient study of these solitary wasps and their habits.

Chapter LV

Wonder Ways of the Solitary Wasps

By John J. Ward, F.E.S.

Author of "Insect Biographies"

Many people begin to study the wasp at the point of its sting; although, on the other side, it may be contended that is the point at which the wasp begins to study us. There are, however, many wasp species that never trouble us with their stings, or ever even annoy us at our picnic parties; indeed, whose whole function is to render valuable service in our gardens, woods, and fields. Such are the solitary wasps—insects scarcely known except to the working entomologist, yet whose life stories are of astonishing and absorbing interest.

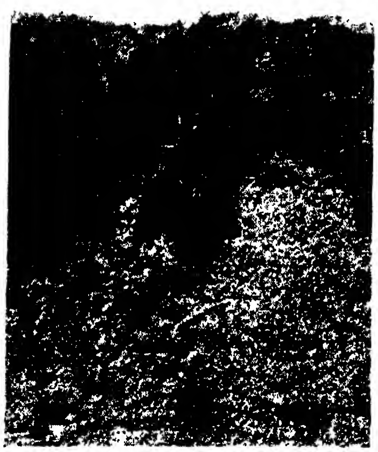
These insects, found in most parts of the world, may be divided into two classes: sand wasps, or digger wasps (*Fossores*), and mud wasps (*Odynerus*). There is no social life; each female of the species constructs a nest of her own and stores it with food material for her offspring. In the case of the digger wasps, some species construct a burrow in sandy soil, or amongst sand dunes, while others prefer to bore a wooden post, or a bramble stem. Of the sand-burrowing type *Ammophila sabulosa* is a good example, an insect nearly one inch in length, with black head and foreparts, a long, stalked body, orange red in colour, and terminating in a pear-shaped end, the latter half of which is black. In sandy places this insect is sometimes quite abundant, and its borings may be seen in large numbers. For hours together in the bright sunlight it is occupied in sinking its vertical shaft, throwing out the loose sand, and carrying away in its powerful mandibles bits of gravel and the larger particles of earth; for its mouth weapons are, in this species, the chief excavating tools.

When the burrow is nicely drilled to a depth of about three inches, the mother wasp turns to the heap of excavated bits of gravel she has thrown aside and, carefully selecting a suitable piece, she returns to her tunnel and cleverly fixes it across the entrance. Then, after a rapid run round the mouth of the burrow she takes to her wings. It may be an hour or two before she returns, for she has gone on a hunting expedition to capture the quarry to provision the cell she has just constructed.

In due course our patience is rewarded, for she appears amongst the tufts of grass well astride a huge caterpillar many times her own weight, which she is holding with her powerful mandibles and dragging along with difficulty. As she approaches the burrow she seems a little doubtful as to its exact location and, releasing her capture, she rushes here and there in an excited manner, continually returning to the caterpillar as though it might escape. There is no fear of that, however, for although it is alive, yet it is under the control of a powerful anæsthetic imparted to its nerve-centres by a series of stings administered by the wasp when it effected its capture.

At last she has arrived at the shaft, and with great speed she removes the covering stone, and then rushes back to her quarry. Getting a good grip, she then proceeds direct to the entrance of the burrow, and both wasp and caterpillar disappear into the hole. When, shortly afterwards, she reappears, she rapidly shovels sand into the burrow, occasionally dropping in one or two of the bigger pieces of gravel as the surface is reached. Finally there is another scattering of sand grains, together with a few cut grass blades, the whole strewn about so as to hide the burrow completely from view.

The mother wasp is then free to construct another tube, for she has successfully provided an ample supply of fresh meat food for one of her offspring. If we unearth the caterpillar, on the side of its body a conspicuous white egg will be found, and from that egg will hatch the young wasp grub with its food supply all in readiness. If the caterpillars are of smaller size, there may be two provided. By some marvellous instinctive calculation the wasp is able to anticipate the exact food ration necessary to allow of the full development of the wasp grub until it is able to pupate in the cell in which it was born. When it becomes a wasp the following year there is no difficulty in its emergence from the burrow, for it then possesses mandibles and strong legs well adapted for sand manipulation.



MUD WASP, LIFE SIZE

Here is a wasp that never troubles us with its sting or plagues us at meal times in the summer. It helps to preserve plants by preying on destructive caterpillars

While the above life story may be taken as typical of the digger wasps, yet there are many variations in the habits of the different species and genera. The members of the genus Pompilus store their cells entirely with stung and paralysed spiders instead of caterpillars. In another group (*Sphecoidea*), of which there are nearly a hundred British species, and which includes the *Ammophila sabulosa* whose life story has here been told, there are not only earth and sand burrowers with caterpillar provender, but also borers into decaying

with a variable number of small caterpillars, and the nests are usually attached to heather stems. Of the genus Odynerus there are sixteen or more British species, most of which build mud nests, although some adopt the digger wasp's method of using bramble stems; but even then sand grains are employed for lining the stems in which the cells are made.

The mud wasp's method of building is extremely interesting. There are two species (*O. parietum* and *O. antilope*) which have evolved a distinct liking for the mortar between the bricks of a well-built house as a building site. The better pointed-up the mortar is, the more likely is the wall to be selected for a row of cells. Since insects more

wooden posts, old trees, or dry bramble, briar, ash, and other stems, from which they excavate the pith, and in most cases store their cells with two-winged flies of the house-fly type, especially preying upon the black and yellow-banded hover-flies. Some species have specialised so far as to capture exclusively one genus of prey.

It would seem that these wasps are Nature's means of guarding against an excess of some of the insect species on which they prey. On one occasion I found on a sandy track of the Devonshire coast some thousands of the newly-made burrows of *Ammophila sabulosa*, with wasps themselves also in abundance, but not a burrow contained a caterpillar. For a whole month close observation never revealed a caterpillar, and eventually the wasps disappeared, leaving their open burrows. The only explanation I am able to offer is that probably the previous year the wasp species was in excess, as sometimes happens with these insects, and in their search for caterpillars they collected them so effectively as almost to bring about their complete annihilation in that particular area. When the wasp progeny emerged the following spring, with inborn instinct they proceeded to form their burrows, but their search for caterpillars proved fruitless.

DIGGER WASP AND ITS MOUTH PARTS

In the excavating operations in which it engages while making the shafts for its nest the digger wasp uses its mouth parts. In the lower photograph we see, highly magnified, the feelers, and the tongue, the mouth, and the horny toothed mandibles. The upper photograph shows the wasp itself and the **shaft** it has dug for an egg.

Leaving the fossorial wasps, we may now consider the mud wasps, a more advanced family nearly approaching the social types. But two genera are represented in the British Isles, namely Eumenes and Odynerus. Of the former genus there is but a single British species (*E. coarctata*). This insect forms little globular nests built of mud, or sand grains agglutinated with mucus, which, in common with all the members of the mud wasp family, are stored

often appreciate old buildings for nesting purposes, it was for a long time somewhat puzzling why these wasps should prefer to associate themselves with new, and especially smooth, well-built walls. One day, however, their secret was revealed, for I espied a common blue tit making occasional jumps from a window-ledge in an effort to reach a row of mud wasp's cells arranged on the window frame. The smooth brick wall does not provide a landing-stage for the tit; but when a window-ledge is near the persistent tit will see to it that no caterpillars remain to serve as mud wasp grub provender.

These pretty little mud wasps are often seen during the month of June, although a second generation may appear in late summer. Sometimes before building the wasp will lay out a building site, bringing little dabs of cement and arranging them more or

J. J. Ward

GRUB, PARASITE, AND NEST OF THE MUD WASP

For the sake of exact observation a wasp grub was removed from its cell and placed, with its store of caterpillars, in a glass tube (bottom left). It is seen sucking the juices from its last caterpillar. The bottom right-hand photograph shows a mud wasp's cell with a grub inside it and, on the grub, a parasite wasp which will deposit its egg on the grub's body. When the egg hatches the parasite larva will feed upon the mud wasp's grub. Above is (left) a nest photographed through a window and (right) the same nest one day later with an extra cell

DIFFERENT ARRANGEMENT OF MUD WASP CELLS

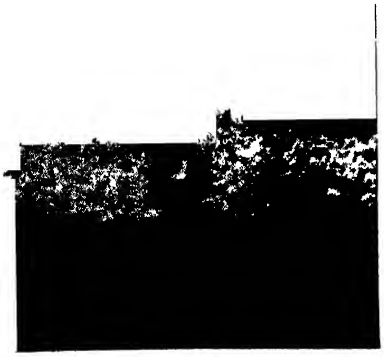
Sometimes the mud wasp builds her cells in a single row, sometimes, as here (bottom), with one row upon another. In such a case the grubs in the top row hatch first and those in the lower bite their way up into the empty cells above and so escape. The upper photograph shows a row of cells built on a new wall.

less in line for even a yard in length. It then begins to build its cylindrical cells at one end of its selected site. Considering that the wasp will probably not live for more than three weeks, its building project is a very ambitious one. If all goes well, it may build forty or fifty cells, all of which, quite unaided, it stores with caterpillars; not infrequently, after building some eight or ten cells, it changes its site and makes a fresh start, probably to avoid the danger of "putting all its eggs in one basket."

The name "mud wasp" seems to imply that these wasps collect mud for building purposes. Such, however, is not the case. What the wasp does is to select a particular piece of sandstone to which it continually returns, each time scraping it with its mandibles until it has obtained a mouthful of sand grains, which it mixes with saliva to form its cement. Each little mouthful is moulded into a ring and plastered round the mouth of the tubular cell, and can be seen as a moistened layer immediately after it is added; but it dries hard before the next mouthful is brought.

When we remember that the little wasp is working in bright sunlight, it is somewhat astonishing how it is enabled continually to moisten the material from its salivary glands. It may be that it is able to store a supply of water in its body, for at intervals it ceases to visit its nest and its sandstone, and may be away for an hour or more; probably it is then seeking a fresh water supply and feasting at the flowers—for the wasp itself feeds on pollen and nectar. Another curious point is why it should return time after time to the same piece of sandstone, often at some distance from its nest, while other pieces of what are apparently the same kind of stone are close by. That may be purely instinctive behaviour, the wasp having found a suitable supply goes to that source with automatic precision, and has not the reasoning faculty to select a piece nearer to its nest and so save itself much time on its numerous journeys.

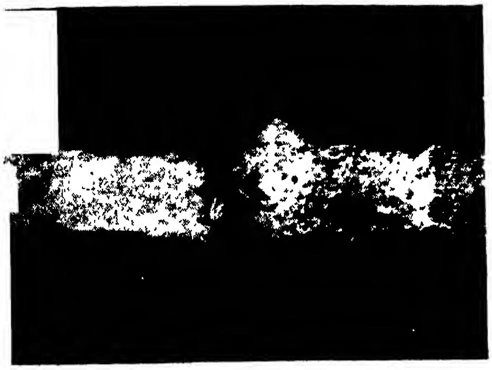
When the cell is completed a large sausage-shaped egg is deposited and attached on a delicate stalk to the interior of the cell wall. Then six to twelve stung and paralysed caterpillars are closely packed in like sardines in a box, except that they are placed in a coiled position to fit the cell. The cell being filled the wasp then closes it with a lid of cement, which serves as a floor for the next cell to be made.



Nest

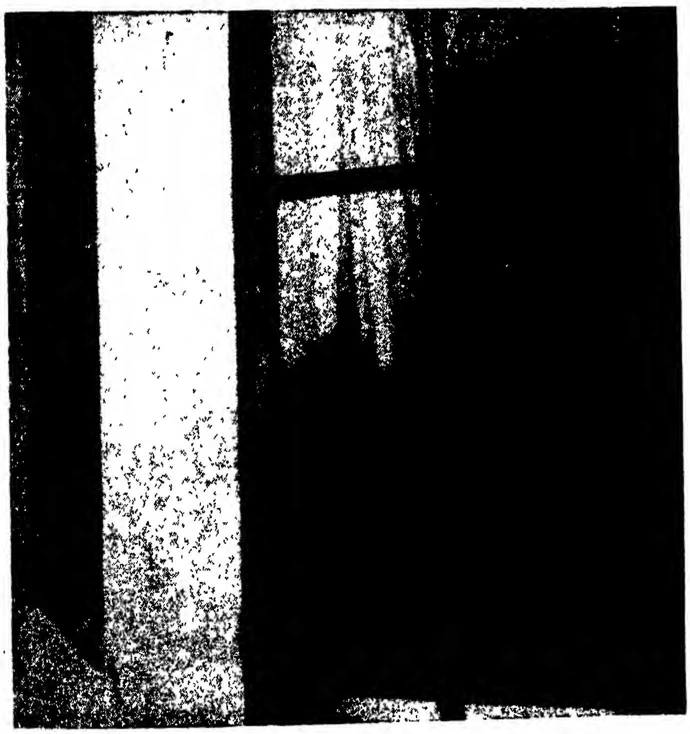
Wasp alighting

About to enter burrow



Entering burrow

Inside the burrow



Window frame with mud cells

Wasp cell damaged by blue tit

Cell opened showing wasp egg

ONE OF THE SOLITARY WASPS: ITS NESTS AND ITS ENEMIES

The mud wasp likes to construct its nest on the mortar of a newly-built wall, because such a wall affords no foothold for the blue tit, which is a great raider of mud wasp nests, since the bird knows it will find a free meal of caterpillars, laboriously collected by the mother wasp, inside. The mud wasp does not collect pieces of mud for building purposes, but manufactures its own by scraping a piece of sandstone with its mandibles, and then moistening the grains with its own saliva. The photographs are by J. J. Ward.

THE CUCKOO IN THE NEST

Here is a three-days' old cuckoo wasp grub (left) photographed in a glass jar for observation. It has the store of caterpillars, alive but paralysed, provided by the mud wasp for her own grub. After eight days (right) they are sucked to nothing.

Sometimes the cells are grouped irregularly instead of being arranged in a single line, in which case the lower ones are buried beneath the upper and last formed. The problem of the escape of the wasps from the lowermost cells is solved by the wasps in the upper and last formed ones emerging first, those beneath them biting their way through their cells into the empty ones above. The grub that appears from the egg, which hatches in about three days, disposes of its caterpillars at the average rate of one per day. It then covers its body with a silken sheet, under which it changes to the pupa stage, remaining in the cell until the following June, when the wasp bites its way out and once more begins the cycle of life which has been described.

These mud wasps are up against a formidable foe in the form of another family of solitary wasps (*Chrysididae*), insects gorgeously attired with bodies of glowing ruby-red, while their heads and foreparts glisten with splendid metallic blues and greens. Making no nest of their own, the females of these jewel-like insects search the walls and crevices where mud wasps are building, and just before a cell is closed stealthily enter it and leave there an egg in much the same way as the cuckoo selects and uses the nest of another bird as a home for her egg.

From that egg comes a "cuckoo wasp" grub, whose first business is to seek for the sausage-shaped egg of the mud wasp, and then to suck it. Having in that manner entirely disposed of the mud wasp grub problem, it then proceeds to devour the caterpillars provided by the mother mud wasp for her offspring, and completes its development in the cell instead of the rightful owner.

There are even more insidious foes that attack the mud wasp grub, tiny wasps (*Chalcididae*) so minute that even when two or three abreast they can pass through the eye of a fine needle. These microscopic insects penetrate the mud walls of the cells to deposit their eggs on the body of the wasp grub. But it sometimes happens that both cuckoo wasps and chalcids are frustrated in their parasitic habits, for it may be that the caterpillars captured by the mother mud wasp were already carrying eggs from an ichneumon wasp; in which case those eggs hatch first, and the ichneumon wasp grubs are the winners, devouring all the provender that the cells contain. Many other enemies might be mentioned, for the story of parasitism is a very involved one.

This, then, is the remarkable story of the solitary wasps. Elsewhere in this work there is given some account of the paper-making wasps—those which live in communities and contrive wonderful nests out of wood pulp. They, the pests of summer picnics and the bane of fruit growers, have a life, quite apart from man, which very well repays a little study and attention. The man who goes to destroy a wasps' nest in some grass bank by asphyxiating the inmates; or to annihilate the inhabitants of one of those apparent lumps of mud which are seen hanging from the branches of trees and which are really the nests of tree wasps, is certainly putting an end to a nuisance to human beings. But he is also exterminating a large and organized community of perhaps unguessed interest, as we shall see.

CUCKOO WASP LOOKING FOR A NEST

This is an enlarged photograph of a parasite cuckoo wasp hunting along the top of a wall for the nests of mud wasps, where she may deposit her eggs. This parasite wasp is gorgeously coloured with a ruby-red body and a blue and green head.

Chapter LVI

How Wild Animals are Caught

By G. M. Vevers

Superintendent of the London Zoological Society's Gardens

The shooting of big game and the more modern method of hunting them with a camera in their native haunts are generally regarded as being two of the most dangerous and thrilling things a man can do, but both these pursuits undoubtedly take a second place when compared with the risks which are run by those who engage in the capture of wild animals alive. There is, however, a lamentable lack of literature upon the subject as those engaged in the trapping of live things for the most part do so for a living and apart from their natural unwillingness to give away trade secrets, they generally have neither the will nor the opportunity to write about their experiences.

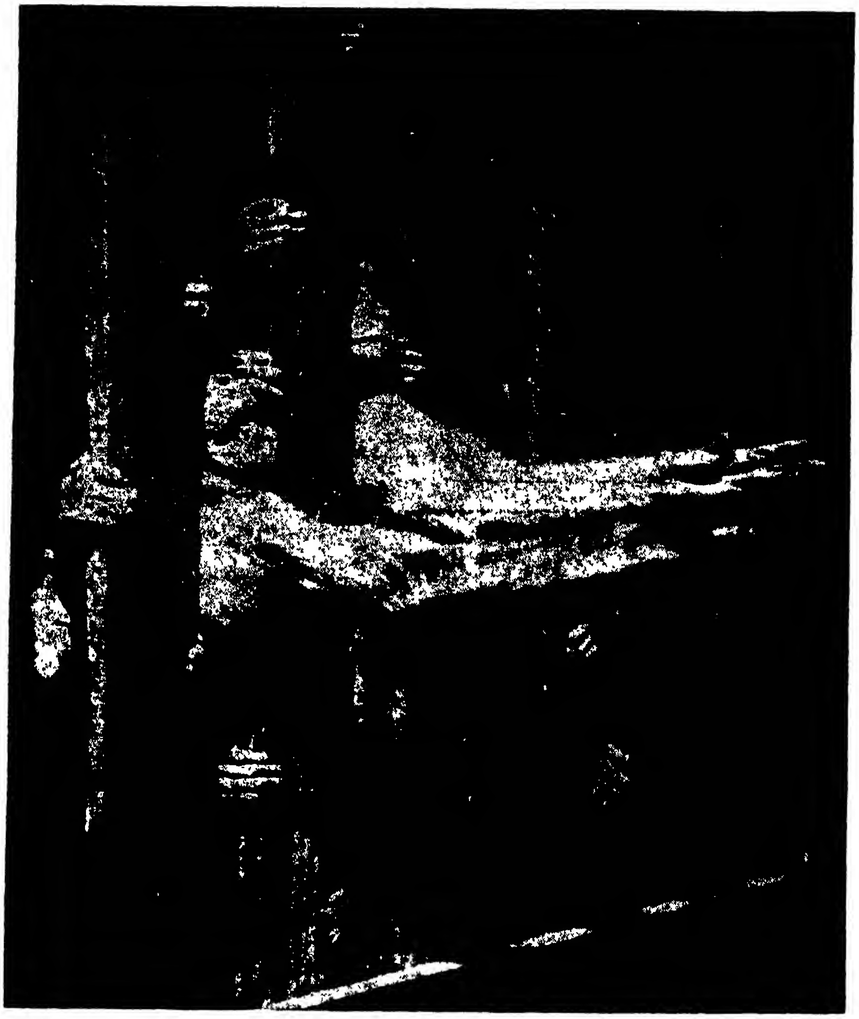
In recent years there have been one or two striking exceptions to this rule. Charles Mayer, who for many years was employed by Barnum and Bailey in catching animals for their travelling menageries, has in his book on the trapping of wild animals given an account of many adventures in the jungles of Malaya and elsewhere, before which the thrills of a modern "mystery" novel are as mere episodes, and in a still more recent volume the intrepid explorer and hunter, Ben Burbidge, gives a most enthralling description of encounters with whole families of gorillas and the capture of youngsters for the American zoos.

Charles Mayer's life would appeal to anyone with the schoolboy love of adventure. To begin with, he ran away from home at a tender age to join a circus menagerie which happened to pitch its tent in the square of his native town. Starting at the bottom rung of the ladder, he worked himself up until he became circus manager and the friend of the great Barnum, who gave him his first commission to go to India and buy a "fourteen-foot elephant," an animal which never existed outside the rather vivid imagination of some Bombay dealer.

Although this expedition ended in disappointment, Mayer saw enough to realize that the East held great possibilities for the animal collector, and we next hear of him learning to speak the Malay language and catching a thirty-foot python in Sumatra. This snake had just swallowed a large pig, and was in a more or less torpid condition when Mayer found him and roped him round the neck; before he was boxed, however, he managed to crush one man to death in his coils, and injured several others by knocking them flat with his lashing tail. The capture of the python earned Mayer a great reputation as a hunter of living things, and very soon he was engaged in an elephant drive on behalf of the Sultan of Trengganu—one of the states of the Malay Peninsula—whose rice crops had suffered severe damage by the invasion of a herd of these destructive animals into his territory. The capture of living elephants on a large scale is not a thing to be entered into light-heartedly, for apart from the enormous risk to life and limb in dealing with these monstrous creatures, there are usually weeks of weary toil before the trap or keddah, as it is called, is completed, and very often when this is finished and everything is ready for the drive, the herd has moved on and is a hundred miles away. The work of making an elephant trap is prodigious. This trap is a circular stockade of large trees, each sunk five or six feet into the ground and strengthened outside with other trees to act as buttresses. The diameter of the keddah is usually about a hundred yards and leading up to it is a funnel-shaped stockade with the wings converging to a narrow entrance which can be quickly closed by a strong gate. Surrounding the circular portion of the keddah is a platform upon which the natives climb when the drive is over and from which they select the animals to be tamed and those to be killed. When all is ready, the herd is located and many hundreds of men surround it in a semi-circle and drive the animals little by little towards the entrance of the keddah.

The final scene is one of indescribable confusion. The ever-closing circle of beaters make a last rush with drums and flaring torches to drive the panic-stricken creatures into the trap. During this last stage, many of the younger animals perish, being trampled underfoot by the larger members of the herd. In some parts of India, the keddah is divided into three portions, with narrow entrances leading from one into the other. The first portion is for the capture of the herd, the second is smaller and generally contains a pool of water, and the third is so small as only to be capable of holding one elephant, and it is in this compartment that the animals are roped one by one before they are led out to be tethered to a tree which is the first stage in their training.

Sometimes the pitfall is used in catching single elephants. A large hole fifteen feet deep is dug in a chosen spot known to be frequented by a herd, and then it is covered in with branches and earth, so as to appear as solid as possible. The unsuspecting animal, crashing through the frail covering of the pit, is a helpless prisoner and entirely at the mercy of his captors. The practice, however, of catching elephants in pitfalls has been discontinued as many were killed by being caught in this manner. A third method of capture is by hunting single bulls with female elephants trained for the purpose. Four or five are employed and the mahouts ride on the head, covered in cloths of the same colour as the elephants, so as to render them as inconspicuous as possible. The tusker is followed about by relays of these ridden elephants for days until it is exhausted and finally is taken by means of ropes when it lies down to sleep.



A BOX FULL OF MONKEYS

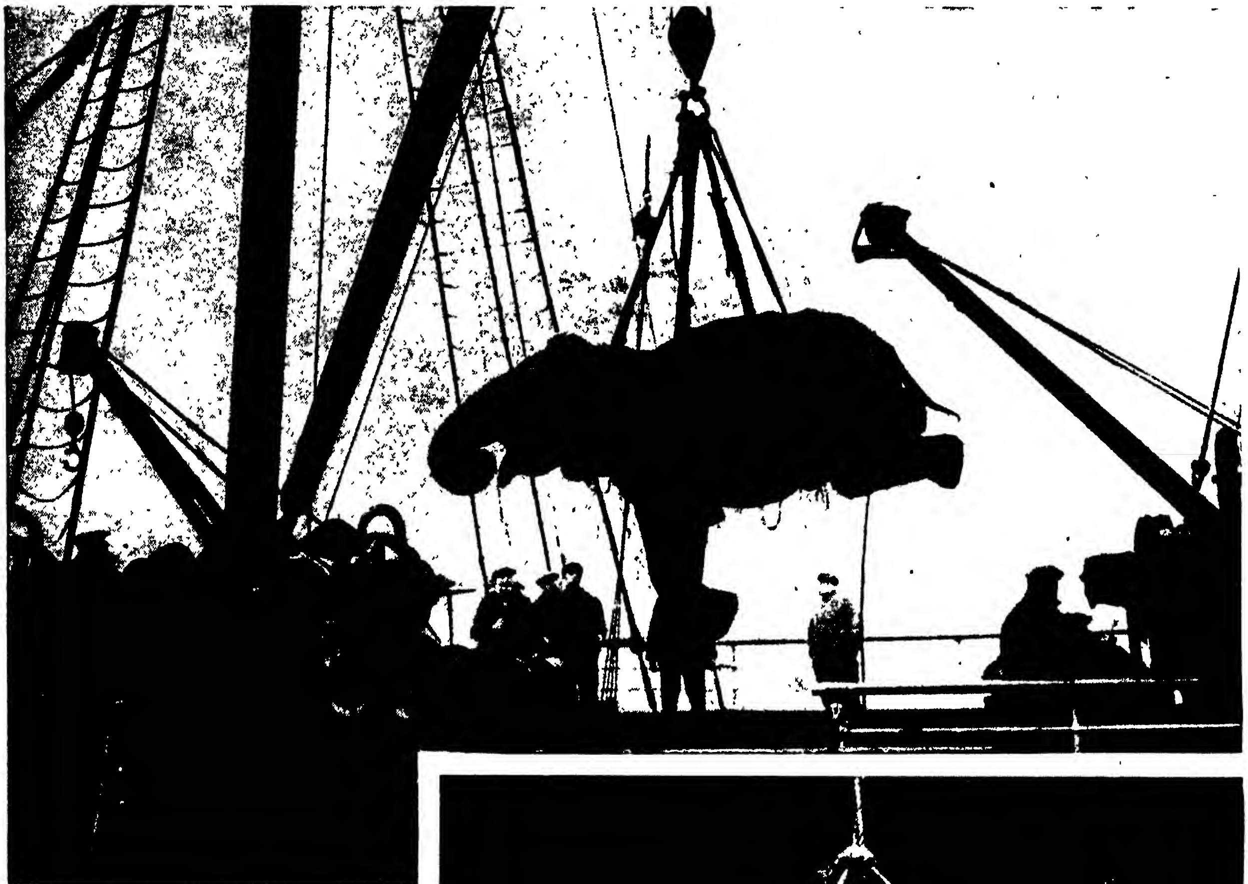
While on their way from their native land to captivity in foreign parts these monkeys caused much amusement on the vessel which brought them over the sea. By the end of the voyage the animals had already learned that their warders were givers of good gifts, as we can see by the array of eager arms outstretched through the bars for the food they hope to receive.

The most sporting and risky form of hunting the elephant alive is by means of a lasso from the back of another elephant, or as it is sometimes done, on foot. It is useless to try to capture young elephants running with their mothers as these animals defend their young with great vigour and the latter cannot generally be captured without first killing the mother. This is not the case with some other animals, such as antelopes and giraffes, where the usual plan is to chase the herd on horseback until the young, which are more easily tired than their parents, can be captured without much trouble.

It was in this way that Carl Hagenbeck's collector, Grieger, captured the famous herd of Mongolian wild horses for the present Duke of Bedford in 1901. In this case the actual capture of the young animals was a simple matter compared with the prolonged preparations necessary for dispatching an expedition into the most inaccessible part of Central Asia, and the task of bringing back the foals and their foster mothers over hundreds of miles of desert, through Russia, until in the end they were liberated in Woburn Park, in Bedfordshire, where their descendants are still to be seen. The journey back to Hamburg took eleven months, and out of fifty foals which had started only twenty-eight survived the hardships of the journey.

Most of the large Carnivora seen in captivity have been caught in the cub stage and reared by hand after the mother has been shot, for it is not an easy matter to capture a full-grown lion or tiger alive, although sometimes it is achieved by the pitfall method and strong nets. Fully grown animals caught in this way are quite untameable, for they never forget the method of their capture and ever after regard man as their bitter enemy. On the other hand, the large cats which have been brought up by man from infancy and treated with kindness are for the most part easily tameable and may be handled with impunity.

The capture of a polar bear alive is an exceedingly perilous undertaking, as it is usually done in small, frail canoes, the hunter runs the risk of being drowned in icy water in addition to being rough-handled by his formidable and savage prey. Two or even three dug-out canoes are lashed together side by side, and when a bear is sighted in the water these are paddled quickly towards him, and when near enough a coil of rope is thrown over his head. The infuriated animal then swims away harder than ever, towing the canoes behind him. This goes on until the animal is exhausted, when the tables are turned and the canoes are paddled back with the now helpless bear in their wake. Usually there is a large boat in attendance, and when the bear is brought alongside further nooses are made fast round his body and he is hauled up on to the deck and thrust ignominiously into a cage. Seals, walruses, and sea lions may be caught in a similar manner, but as these are exceedingly rapid swimmers and dive to great depths, they are generally caught from time to time in nets. Most of the seals which are caught off the coasts of Great Britain are taken quite accidentally in the wide-spreading nets of fishing boats.



The capture of a full-grown gorilla is well-nigh impossible, and although adult chimpanzees and orang-utans are occasionally taken alive they do not as a rule live long in captivity, and their capture is not a thing to be encouraged, for the methods employed are of such a nature that the spirit of the animals is broken and they lose the will to live. On the other hand, anthropoid apes which are captured during the first two years of life take to human beings almost immediately, and may live for years in captivity. Of all the apes, gorillas are the most difficult to bring home. They require individual and constant attention and have to be treated in much the same way as human babies, and unless one is prepared to do this it is much kinder to leave them in their natural state. In dealing with the anthropoid apes, more perhaps than in the case of any other kind of animal, a study of their psychology is of the highest importance.

ELEPHANTS TRANSPORTED BY RAIL AND STEAMER

Below is a valuable white elephant just arrived from Asia, being unloaded from the ship to the train at a port of the United States. Above is a young elephant being swung out of the ship's hold in which it has travelled by a derrick at the quay. Notice the elaborate cradle which supports this weighty young creature.

BY THE BANKS OF AN AFRICAN LAKE: ENTICING THE CROCODILE
Crocodiles commonly lie near the banks of the river or lake which they inhabit with just the tip of their snout and their eyes protruding above the water. Thus concealed they wait the coming of man or beast, and then make a rush, and the victim is dragged into the water, held under till drowned and devoured at leisure. Above is a strange scene in Central Africa where a native is luring a crocodile from the waters of a lake by making a tempting offer of food. In the opposite page we see how the attempt succeeded.

Sometimes the word goes out from one of the zoos of the world that a large number of one kind of animal is required to make up a spectacular exhibit or colonise some special enclosure. This was the case when the Baboon Hill at the London Zoo was made. Long before that rocky island was ready the Council of the Zoological Society had commissioned a prominent animal dealer to capture and transport to London at least one hundred sacred baboons from Abyssinia. An experienced man was sent out, who, after four days' journey from the coast into the interior, came upon a large colony of the animals. He had taken with him on camels a number of boxes, each capable of holding four baboons.

NEAR their home he built a little hut with a sliding door to which a string release was attached. Leading up to and inside the hut a quantity of maize was laid down as a bait. Then, retiring behind a neighbouring rock with the string in his hand, he awaited developments. In a short time he made his first capture, the large male leader of the tribe. His difficulties, however, were not over then, for the animal had to be tempted from the hut into a box, and this was done by placing one of the boxes opposite the trap door in the hut and waiting until the captive took it into his head to walk in. All this was done with the other baboons crowding round in a most aggressive manner, wondering what had become of their leader. His disappearance, however, did not dissuade the others from entering the hut, and in the course of a few days no fewer than 107 baboons were captured in this manner and transferred into their travelling boxes. These boxes were then lashed in pairs to the backs of camels and the journey made back to the coast again.

The actual transport of live animals across thousands of miles of sea and land, the feeding of them, protecting them from chill when taken from a tropical to a cooler climate—all these and many other problems have to be overcome by the collector of living things. Special boxes of varying sizes have to be made for each individual animal caught, and these must be carefully padded to prevent the captive creature from injuring itself in its efforts to escape from the box and also from being thrown about in it on board ship during rough weather. Perhaps the most difficult and delicate animal to transport is the giraffe. It is of course useless to attempt to send home a fully-grown specimen, as giraffes attain a height of seventeen or eighteen feet, and a box containing a creature of this size would be too high to pass under the highest railway bridge. The giraffe chosen for export usually does not exceed

CROCODILE TEMPTED FROM THE WATER BY THE OFFER OF FOOD

In the above photographs and the one on the opposite page we have an interesting series showing the gradual approach and emergence from the water of a crocodile, lured by the bait held out by a native. In the upper illustration on this page we see that as the great beast has cautiously advanced up the shelving bank, the native has retreated until the "croc" is emboldened to get as far as resting its snout on the bank. Below we see the animal receiving its reward when three-quarters of its body are out of the water.

DRAGGING A ROPED CROCODILE ASHORE AFTER A HARD STRUGGLE

Catching crocodiles alive is one of the hardest tasks for the collector of wild animals. These creatures are so shy and sink at once if alarmed, so that it is largely a matter of good fortune if a specimen is obtained. The crocodile seen here is by no means full-grown and yet it takes a considerable number of men to drag it to the bank, and this is only accomplished after a terrific tug-of-war. Even when hampered with the ropes the animal makes a good fight for liberty and, once on the bank, brings its dangerous tail into play. One of the natives has seized this active weapon and is hanging on at all costs while the rest try to make sure of their capture.

F. W. Bond

BIG INDIAN PYTHON BEING UNLOADED AT THE LONDON ZOO

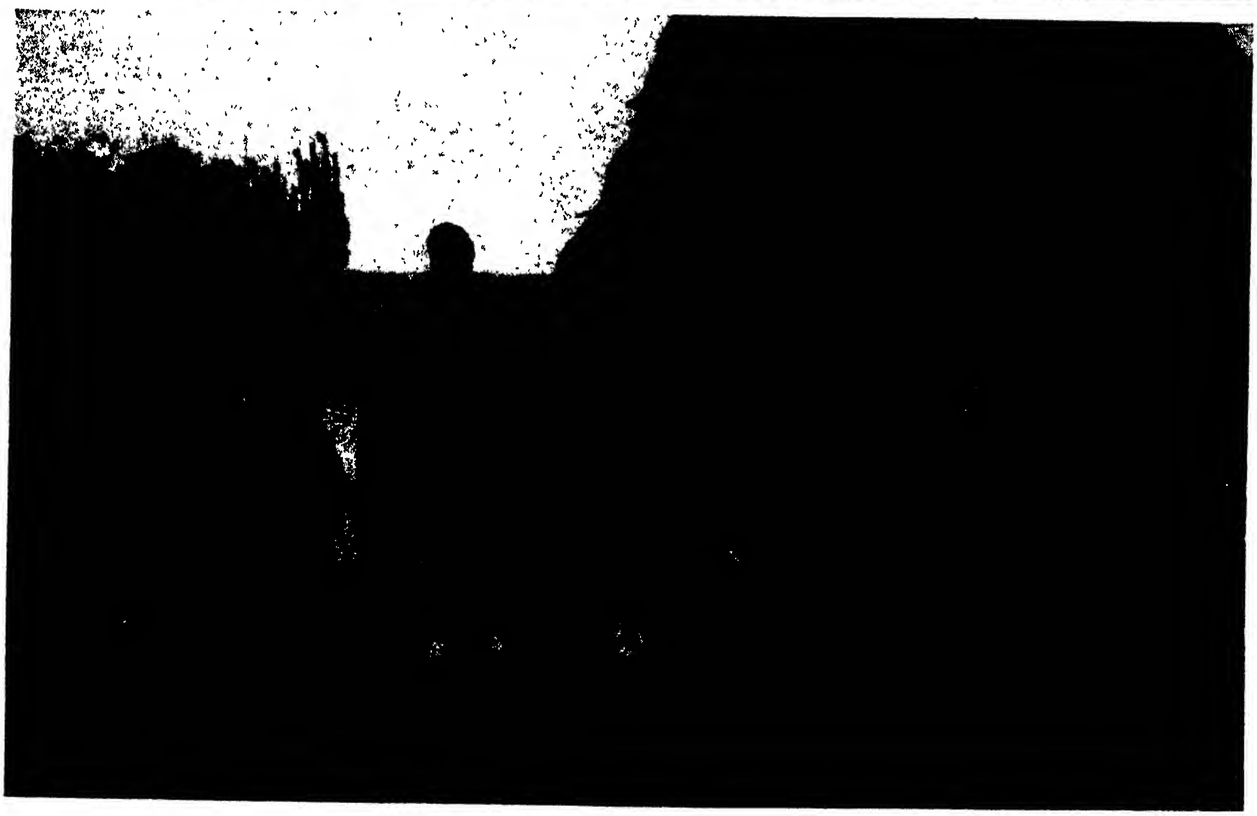
Pythons are only to be captured with any degree of safety after they have fed. These great snakes make enormous meals—a pig or a deer at a time—at long intervals, and spend many hours in a state of torpor while the process of digestion is taking place. Thus a specimen such as the one seen here, can, when once safely in its box, be sent on its journey in a quiescent mood, and requires little attention till it reaches its destination. Then, as we can see, it may take seven or more men to hold it.

ten feet in height, and even a box large enough to contain a creature of this size is an unwieldy thing to handle in the absence of a lifting crane.

NOWADAYS the conditions under which live animals are taken from place to place are very much better than those which prevailed in the past, and the mortality among newly imported animals has decreased enormously. Recently a select committee of specialists under the auspices of the Zoological Society of London has drawn up a set of rules for the guidance of those engaged in the transport of animals. Special attention is called to the shape and construction of boxes, overcrowding of specimens, and the general management of various kinds of creatures on road, train and ship-board. Before shipment it is usual to keep animals for some time in captivity so that they may become accustomed to human beings and to the kind of food that can be supplied to them on the voyage which may by necessity differ from the fresh food which forms their natural diet. It is of the utmost importance that animals should be shipped in good condition and very young creatures and pregnant females should not be exported. As a rule, animals should not be transported from the Tropics to a cold climate during the winter months. Sometimes great ingenuity is required to find a suitable food substitute for certain creatures such as anteaters, which normally live on white ants or termites, a supply of which naturally cannot be taken on board ship in order to accommodate these insectivorous epicures. Condensed milk has been found to be a great standby in all such cases, and even some of the smaller birds and reptiles learn to take it.

The advent of the motor-car has made the transport of animals a very much easier matter than it was in the old days. In the capture of giraffes, for instance, the animals are no longer marched for miles to the rail-head after being caught but are lifted into motor lorries, fitted with caterpillar wheels, which carry them from the actual site of capture to the nearest railway station or even to the port from which they are to be shipped.

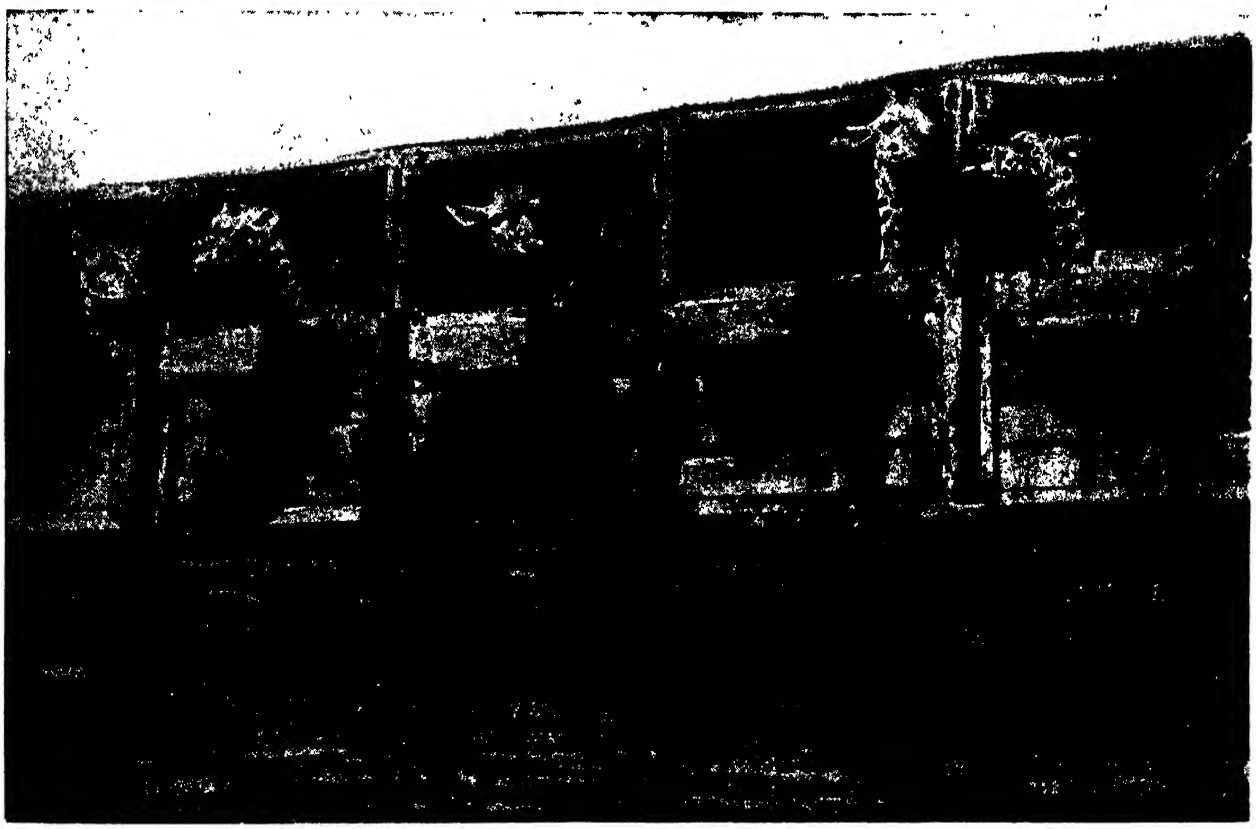
Taken as a whole, birds are very much more difficult to catch and bring into captivity than mammals, while reptiles are perhaps the easiest of all to deal with. The large flightless birds, such as ostriches, emus and cassowaries are generally hunted down on horseback and lassoed with ropes. In South America, the rhea or so-called South American ostrich is captured by means of bolas which consist of two round pebbles joined together by a long thong. The horseman chases the bird until he is alongside, then throws his bolas, which entangle the creature's legs and bring it to the ground. A vivid account of the use of the bolas is given by Darwin in his "Voyage of the Beagle." This practice seems to have been handed down from time immemorial as



E. N. A.

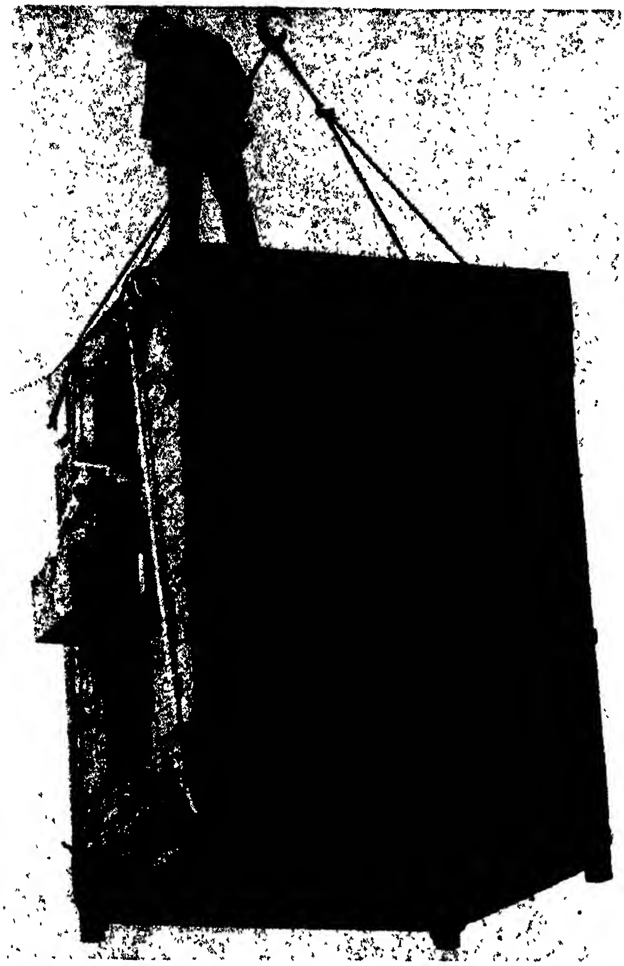
LASSOING WILD GIRAFFES IN THE EAST AFRICAN BUSH

Armed with nothing more lethal than a length of hemp rope, men now pursue the tall giraffe for capture and transference to a zoological garden or for photography, where once they hunted to kill. The upper photograph shows us a giraffe just after being lassoed in the East African Bush The break in the mane along the back of the neck shows where the noose is holding. Great care has to be taken when "roping" a giraffe as a fall might mean a broken limb. When once lassoed, giraffes often seem too bewildered to struggle (bottom).



TRUCK-LOAD OF GIRAFFES AND A FEMALE DECOY FOR A MALE

Only young giraffes can be transported, for a full-grown specimen may stand seventeen or eighteen feet tall, and the height of the ordinary bridge above a railway would prevent a box tall enough to house such a creature from being carried by train. In the lower photograph we see a truck-load of five young giraffes on their way from East Africa to the Berlin Zoo, while above, one method of capturing a male giraffe is illustrated. A female is caught and put in a cage on a lorry. She acts as a decoy for the males, and when one arrives it is quietly roped.



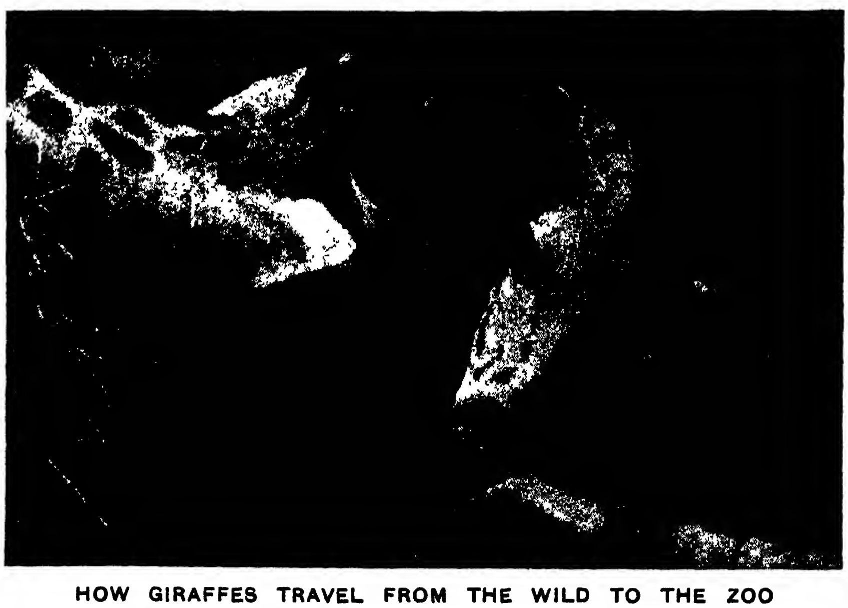
employed by the natives of New Guinea and the neighbouring islands in the catching of the many varieties of Birds of Paradise which abound in this part of the world.

The capture of some species which spend their lives in the tree-tops is not unattended by great risk to life and limb. Recently two specimens of a very beautiful bird known as the cinnamon roller were brought from Portuguese East Africa to the London Zoo by Mr. C. S. Webb, the well-known bird collector, who had spent several weeks in observing these birds through field-glasses as they hawked for insects at the very top of a group of high trees. Marking down the boughs they used most frequently, he climbed up the tree until he was able to reach the branches he had located and smear them with bird-lime. He then descended and went away for some hours to await results. On coming back he was overjoyed to see four birds fluttering helplessly. Once again he made his perilous ascent and succeeded in securing all four specimens alive. His difficulties, however, had only just begun,

bola stones have been found on several occasions in strata of undoubted Paleolithic age.

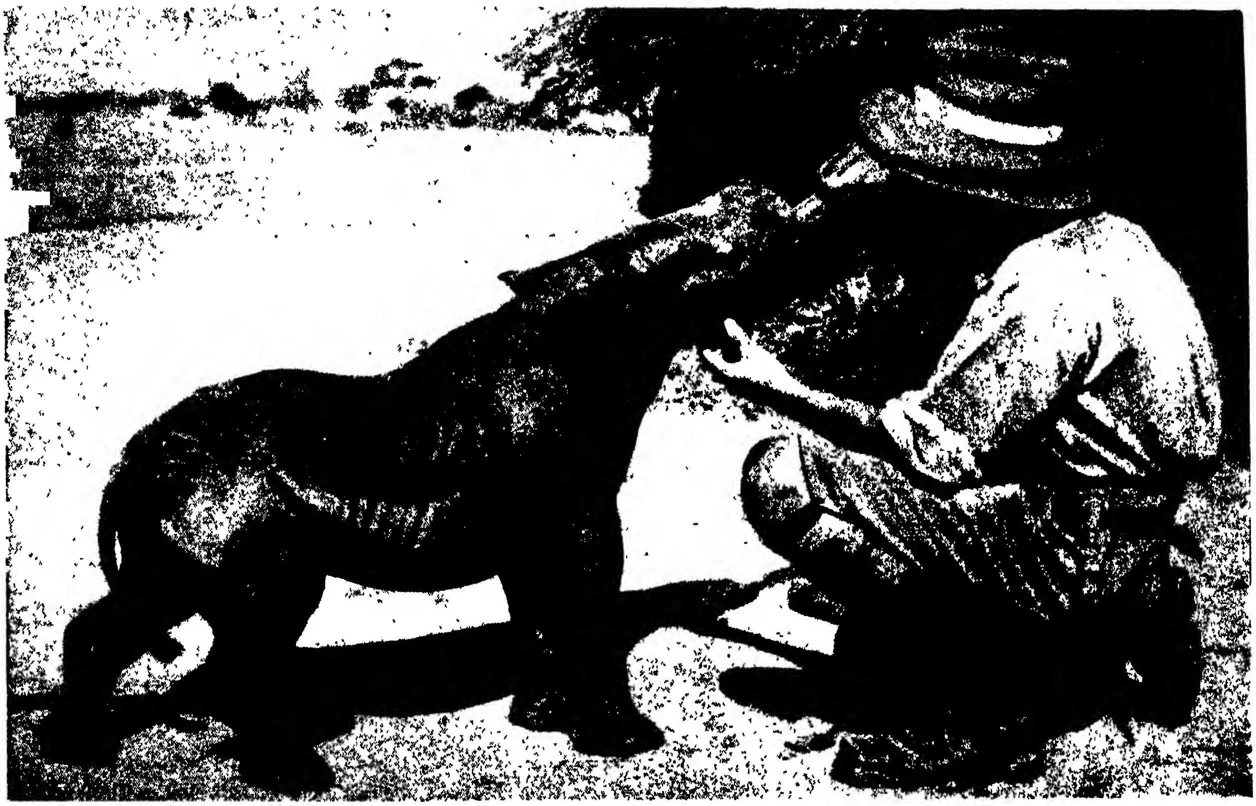
Once caught the easiest way of dealing with an ostrich is to put a sock over its head so that it cannot see, when it can easily be led about by two men—one walking on each side grasping a wing.

The ways of capturing flying birds, both large and small, are legion. The larger kinds such as sea birds and birds of prey are generally taken as nestlings and brought up by hand. The smaller birds may be trapped, netted or caught by bird-lime used in various ways. The bird collector usually relies on native help to a large extent to aid him in the capture of the rarer species. Blow pipe darts and blunt arrows smeared with bird-lime are favourite weapons



HOW GIRAFFES TRAVEL FROM THE WILD TO THE ZOO

An important factor in the capturing and carrying of wild animals is getting them accustomed to human company before and during their journey. By the time they reach that journey's end the animals are often tame enough to feed from the hand, as we see here (bottom). Above is a giraffe having its first view of London as it is swung off the boat at Tilbury.



E.N.A.

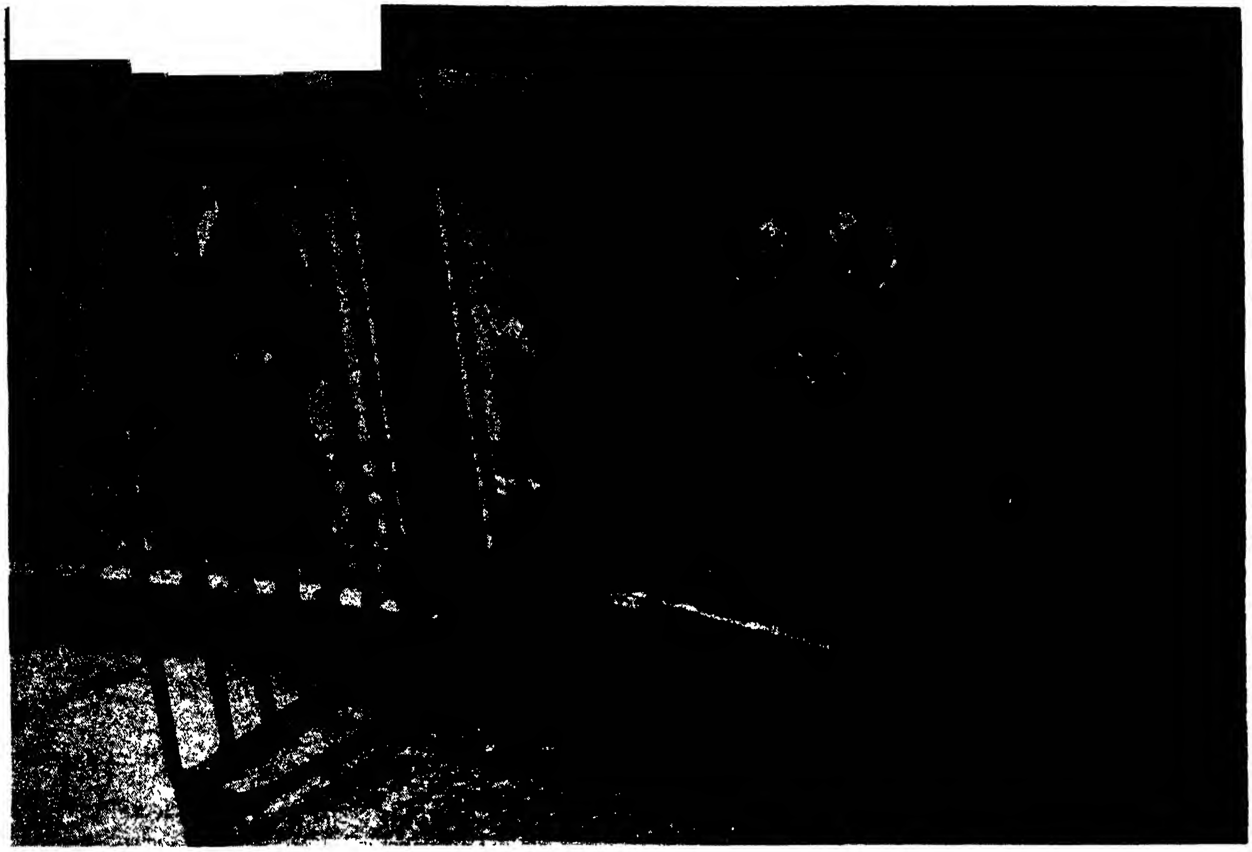
CAPTURED WILD ANIMALS BEING HAND-FED IN THEIR EARLY DAYS

Food is a great problem when the task of keeping a young wild animal in captivity is undertaken. When at the Zoo the right food, or an efficient substitute, is probably quickly available but, when first caught, and particularly during the journey, the question of diet is all important, and the mortality among captured animals before they even reach their ultimate cages is always high. This young hippo (bottom) took readily to a diet of barley-corn while it was being looked after by a native servant, while a baby rhino (top) had to be bottle-fed.

© N A

MAN'S STRENGTH PITTED AGAINST THE BEAST'S

At the best of times the hippopotamus is one of the hardest animals to approach as, not only is its sense of smell extraordinarily acute, but upon alarm it instantly sinks into the depths of the water. In the lower photograph some African natives have succeeded in the feat of capturing a young hippo alive among the reeds of a lake. They are contriving to keep the dangerous jaws which, in an adult can bite through a canoe, open. Above is a young rhinoceros being captured in Tanganyika.



F. W. Bond

ON ARRIVAL AT THE ZOO: TIGER AND RHINOCEROS

Just as a new Zoo tiger began to creep stealthily out of its travelling box and enter the cage in which it was to pass the rest of its days, the top photograph was taken. This is a remarkable view of a new arrival, full of nervous wonder as it surveys for the first time its strange new abode from which there is no escape. A rhinoceros in a crate is an unusual sight, but here (bottom) is one, consigned to the London Zoo and just arrived after many weeks of travel and strange conditions.

THE NEW CAPTURE: GETTING A LION CUB USED TO HUMAN HANDS

As long as an animal, even so fierce a one as a lion, is caught sufficiently early in its life, while it is still in the helpless stage, it can be kept tame and even affectionate until it is adult: then, the large carnivora are unreliable at the best of times. Nevertheless, if an animal has been always used to human company and has received kind usage all this is likely to make the full-grown creature the more tractable in captivity. Here we see a lion cub becoming accustomed to taking food from a human being. Notice that the cub is spotted.

for he found after cleaning them that they refused to eat every kind of food offered and it was only by forcibly feeding them twice a day for many weeks that he was able at last to bring two of them home to the Zoo, the first of their kind ever to be seen alive in captivity.

Reptiles, with the exception of a few poisonous species, and the large constrictors, are perhaps the easiest of all animals to capture and send home alive. Although it is popularly supposed that lizards are poisonous, there is only one genus that is really so. This is the family of Heloderms or Gila monsters which inhabit the deserts of Texas and Arizona. Although the other lizards can bite and scratch and some make use of their tails to inflict severe blows, they can usually be caught fairly easily and handled with impunity. After capture one good meal will last for many days and these and other reptiles are very easily sent home in boxes packed with moss which must be moistened occasionally with clean, fresh water. Large constrictor snakes such as pythons and boas are usually taken during the period of torpor which follows a large meal. Even so, many men are required to deal with anything over twelve feet if it is warm and in good condition. After being boxed, they can be shipped right away and do not need any more looking after until they arrive at their destination. The poisonous snakes, on the other hand, require more care in their capture. Various devices are used, the forked stick being the most common of all. This method of capture is not to be encouraged as very often the snake lashes about and injures its cervical vertebrae. A useful form of snake catcher and one which is less liable to injure the neck is now in almost daily use at the London Zoo. It consists of a leather loop working against a soft pad in the place of the forked stick, and the loop is capable of being adjusted to fit any size of neck. When in use, the loop is slipped over the snake's head and, being drawn tight, is held in one hand so that the other is free to deal with the body and tail. Poisonous snakes are usually boxed for transport in boxes which have an inner lid of wire gauze so that they can be observed with safety. It is important to see there are no knot holes in the wood as venomous reptiles are not pleasant travelling companions.

Taken as a whole, the collecting and transport of wild animals calls for a marked degree of courage, an enormous amount of endurance and an infinite capacity for taking pains. The risks are many and the failures almost as numerous as the successes, for the mortality among newly caught creatures is very high. Briefly, success in bringing animals into captivity can be measured in the terms of the amount of personal supervision and sympathetic treatment which is bestowed upon them after capture.

CARE IN HANDLING THE NEWLY CAPTURED: CHAMOIS IN A STRETCHER

This is a good example of the careful handling required to deal with a highly nervous animal like the chamois. This animal, which is placed by scientists between the goat and the antelope, is an inhabitant of the Alps and other mountain regions of Europe, and has suffered much from persecution. To this its extreme shyness is due, and in these photographs it can be seen what caution is necessary to prevent the creature from injuring itself in its naturally violent efforts to escape. The stretcher is padded with brushwood.

TRAVELLING BY MEANS OF THE TAIL: HANDSOME POLLACK OF THE NORTH ATLANTIC

Fish, in the majority of cases, swim by means of rapid movements of the tail from side to side. The tail does not consist merely of the hind fin as many people suppose, but a considerable portion of the body as well. The other fins help in turning and in rising and sinking. The pollack has three fins on its back, the foremost being sharply pointed. In colour it is a dark green along the back, and this colour lightens down the sides, which are embellished with golden markings, until the underside is almost white. The pollack is a valuable food fish, and is caught in considerable numbers off the Devonshire and Cornish coasts, and also occurs in Norwegian and North American waters. Its usual length is a little under two feet.

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Chapter LVII

Travelling Without Legs or Wings

By W. P. Pycraft

Author of "The Courtship of Animals"

FORCE of habit has made us think always of animal locomotion in terms of legs or wings, so much so that we are apt to forget that many creatures contrive to travel, and often swiftly, without any such aid. The means adopted to achieve this are surprisingly varied.

Directly we begin to ponder over the matter we ask ourselves how did legs and wings come into being. Though there can be no completely accurate solution of such a problem we can come very near it.

Let us begin our survey of this theme with the lowly amoeba, which can be obtained, for the microscope, from the mud of ponds. A mere speck of jelly without definite shape, for it is always changing, it moves along by virtue of an inherent "irritability" of its substance. It progresses by "flowing" movements. The direction in which it is travelling is indicated by a sort of thrusting forward of a part of its outline, a kind of blunt "finger" grows out from the body, which presently flows forward, as it were, to merge with its tip, and presently another "finger" will appear from another area of its circumference, and so it travels in an apparently aimless way by means of these extraordinary "pseudopodia," or "false-feet" as they are called.

An advance on this is made by other protozoa when the substance of the body throws out permanent, excessively delicate, thread-like processes which are actively vibratile. Their rapid side-to-side movements draw the body along as the propeller of an aeroplane draws the 'plane along. Such threads are known as cilia.

THE minute rotifers, creatures much higher in the scale, travel with great speed by means of such cilia which, placed around the mouth, serve the double purpose of organs of locomotion and whisks to whirl particles of food into the mouth. Some, like the wheel animalcule, can also "walk," somewhat after the fashion of a looper caterpillar. Taking a grip of the ground with a pair of short "legs" at the end of the body, it bends forward and gets another hold with its head, then, releasing the legs, doubles the body up so as to bring the legs up to the mouth, and then takes a fresh hold by the head.

Leeches "walk" in a similar way, but when they are in a hurry they swim by undulatory movements of their long, lithe bodies.

The earth-worm crawls up and down its burrow, and over the ground, by means of short, stiff bristles, which run down almost the whole length of the body, while in many of the marine worms these bristles become flattened out to form swimming paddles.

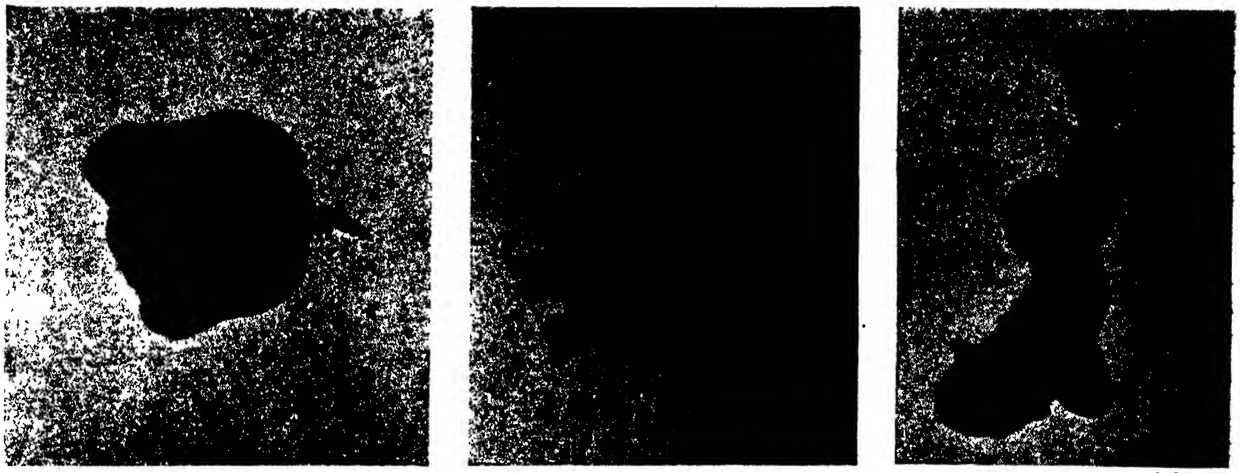
Those repellent creatures which we call "maggots" and the fishermen call "gentles"—the larvae of the blow-fly—contrive to crawl, and with no small speed, aided by nothing more than tiny hooks which they use by alternate contraction and expansion of the body. Similar rhythmical contractions obtain in the snail, where the underside of the body, or "foot," during locomotion is thrown into a series of wave-like movements which carry the body forward. The slime-tract which they leave behind them doubtless helps, but no such tract is left by water-snails, which crawl by the same movements of the foot.

Among the higher animals which crawl without the aid of legs the snake is the most familiar example. "Upon thy belly shalt thou go all the days of thy life." But the implication that the serpent lost his legs suddenly is not borne out by fact. The under surface of the body of a python will show, on each side of the vent, a pair of conical horny spikes, the last vestiges of a once functional pair of hind legs. All trace of the fore-legs has vanished. How then does the snake crawl?

WITH the gradual dwindling of the legs there has followed a corresponding lengthening of the body by the addition of vertebrae to the spine, each vertebra bearing a pair of ribs. There may be as many as two hundred pairs and they function much like the legs of a centipede—but inside the body. Here is another problem. How does the snake, having his legs—the ribs—inside the body, contrive to "walk"? If the belly of a python be examined it will be found to be marked by a number of broad, transverse plates or scales: and to the inner surface of each end the free end of a rib is fixed. As a consequence, as each pair of ribs moves forwards it sets the hinder edge of the scale on end, sufficiently to enable it to get a grip of the ground, and so, as the ribs' next move is backward, the body is thrust forward.

The sea-anemones are generally regarded as creatures which are "fixtures." But this is by no means true. They can, and do, shift from one place to another by movements of the "foot," akin to those of the snail. There are some which go much further than this. There is a Madeiran species, for example, which can crawl with speed, and furthermore detach itself and swim head-downwards at the surface of the sea. There are several species of the southern oceans which have improved on this method of travel, the base of the "foot" having been transformed into a gas-filled bladder. Needless to say they have altogether abandoned a fixed life on the sea-floor.

One more of these "creeping things" remains to be mentioned. This is the beautiful polyzoan *Cristatella*. This animal lives in colonies, and one wonders what is the controlling force which secures common consent from all the individuals of the colony to travel in one and the same direction.



J. J. Ward

HOW THE LOWLY AMOEBA PROGRESSES BY MERELY "FLOWING"

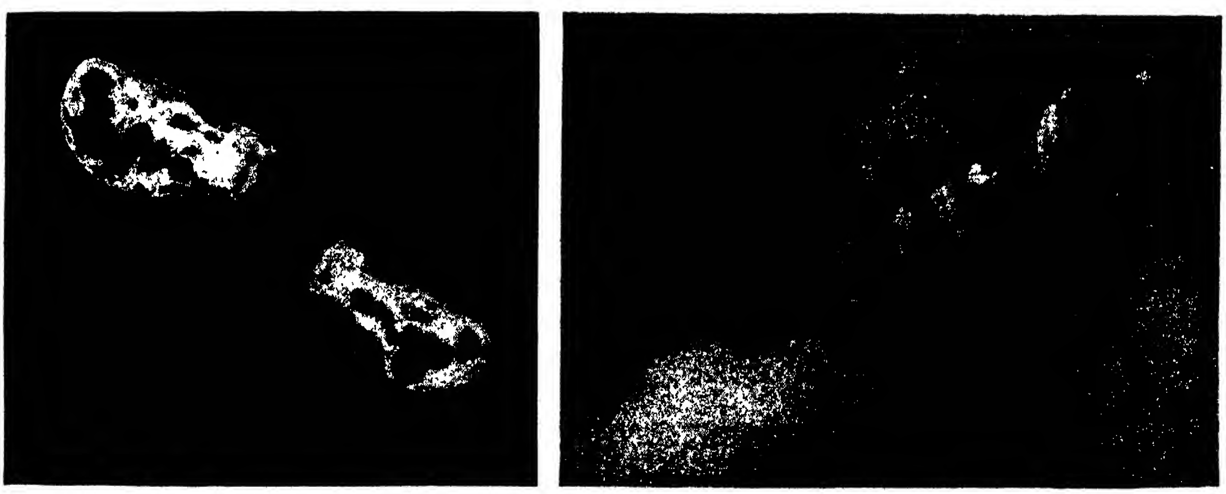
Through the microscope one can watch the amoeba, which is a speck of jelly without any definite form, and can be obtained in most ponds. Its method of progression, as illustrated above, is (left) to extend a part of its substance and to continue the process (centre) until it gradually attenuates its mass in one direction (right). Then the rest of its body flows into the extremity of the extension and the process is repeated in an apparently aimless way. This is how one of the lowliest of living things travels

We are accustomed to think of "shell-fish" as peculiarly helpless creatures, yet we find the cockles buried deep in the sand at low water, and jumping joyously to meet the incoming tide! They rise from the dead as it were without any tell-tale sign, springing out of the ground by the action of the foot. The beautiful pecten with its glorious vermilion red foot swims gaily by rapidly opening and closing the shell-valves: using them with a flapping movement as though they were wings. Some of the mollusca have taken entirely to a "life on the ocean wave."

These are the pteropods. The shell is either wanting or extremely reduced, and swimming is effected by means of expansions of the foot to form a pair of "wings," which in this action recall those of a butterfly. Save when driven by currents they never come near land, and for the most part come to the surface of the sea only by night. When they wish to sink they fold their "wings" and drop slowly downwards. Their numbers are as the sand of the sea-shore: in their chosen waters in the great oceans, even in the icy Arctic waters, they exist in such vast myriads as to colour the sea for miles. They formed the chief item in the diet of the once abundant Greenland whale. These "snails of the open sea," as we might well call them, have but little power of control, but must drift with the current.

Very different is the case with the squids and cuttlefish, the most highly developed of all the mollusca, some of which attain to a gigantic size, rivalling even that of whales.

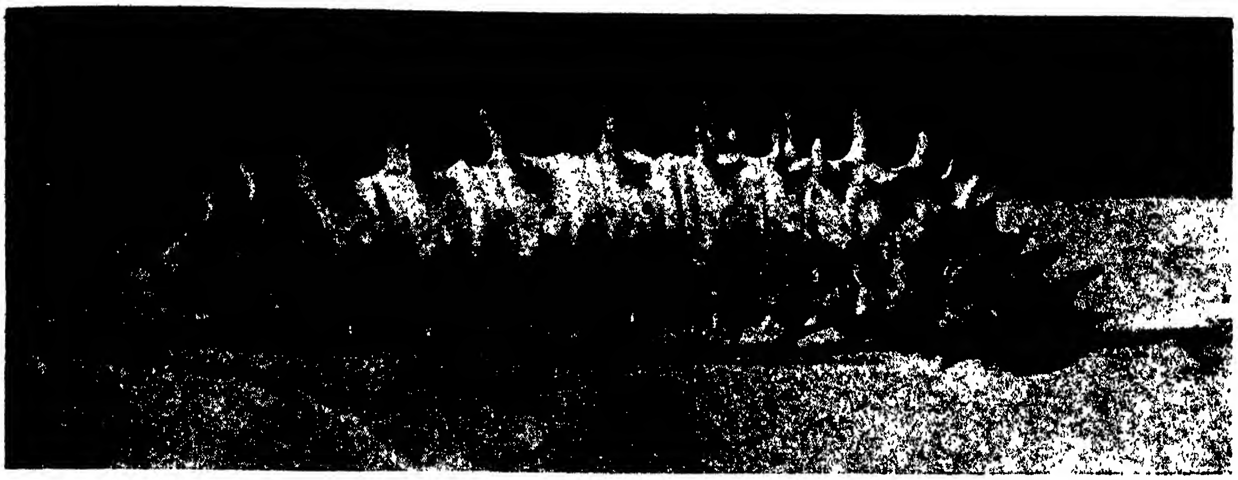
Not the least remarkable thing to be said of these singular creatures concerns their method of defeating their enemies. They do not fight, but run, and



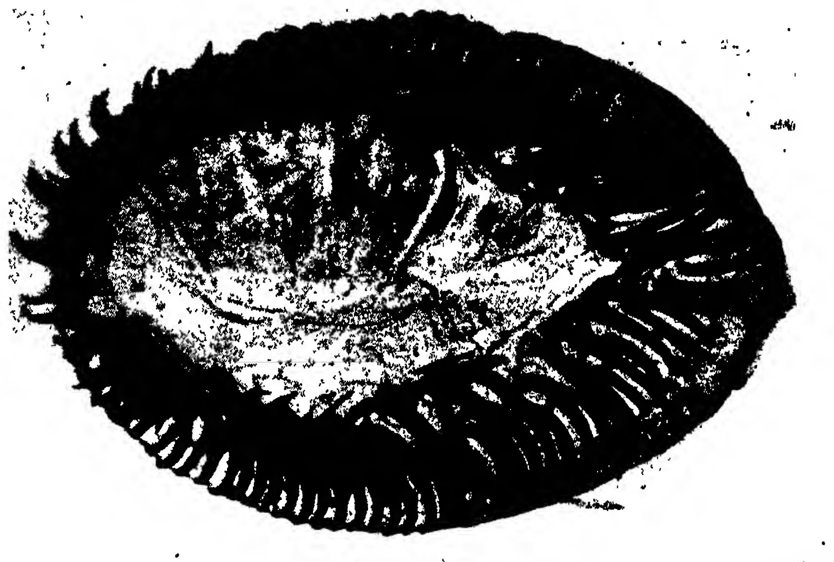
Martin Duncan

ROTIFERS AND A TUBE WORM AS THEY MOVE IN THE WATER

With the rotifers (left), which are considerably higher up the ladder of life's development than the amoeba, definite organs of propulsion have been developed. These are very delicate and threadlike, and are placed round the mouth. Not only do these organs, which are called cilia, serve to propel the rotifers, but also to whirl particles of food into the mouth. On the right is a parchment tube-worm. It leaves its tube home at night and glides along the floor of the sea, where it lives, by means of growths at the sides of its body.



they run backwards! But how, in avoiding the danger which faces them, they avoid the unseen dangers behind them towards which they are rushing, is a mystery. This feat of "running" backwards is accomplished by drawing water into the spacious and closed mantle-cavity, and forcing it out again by expelling it through a narrow tube known as the siphon. The thrust of the column of water is so great as to send the body backwards at a surprising speed. Some of the Crustacea can emulate this feat, but by a totally different mechanism.



J. J Ward

CATERPILLARS AND THEIR MEANS OF MOVEMENT

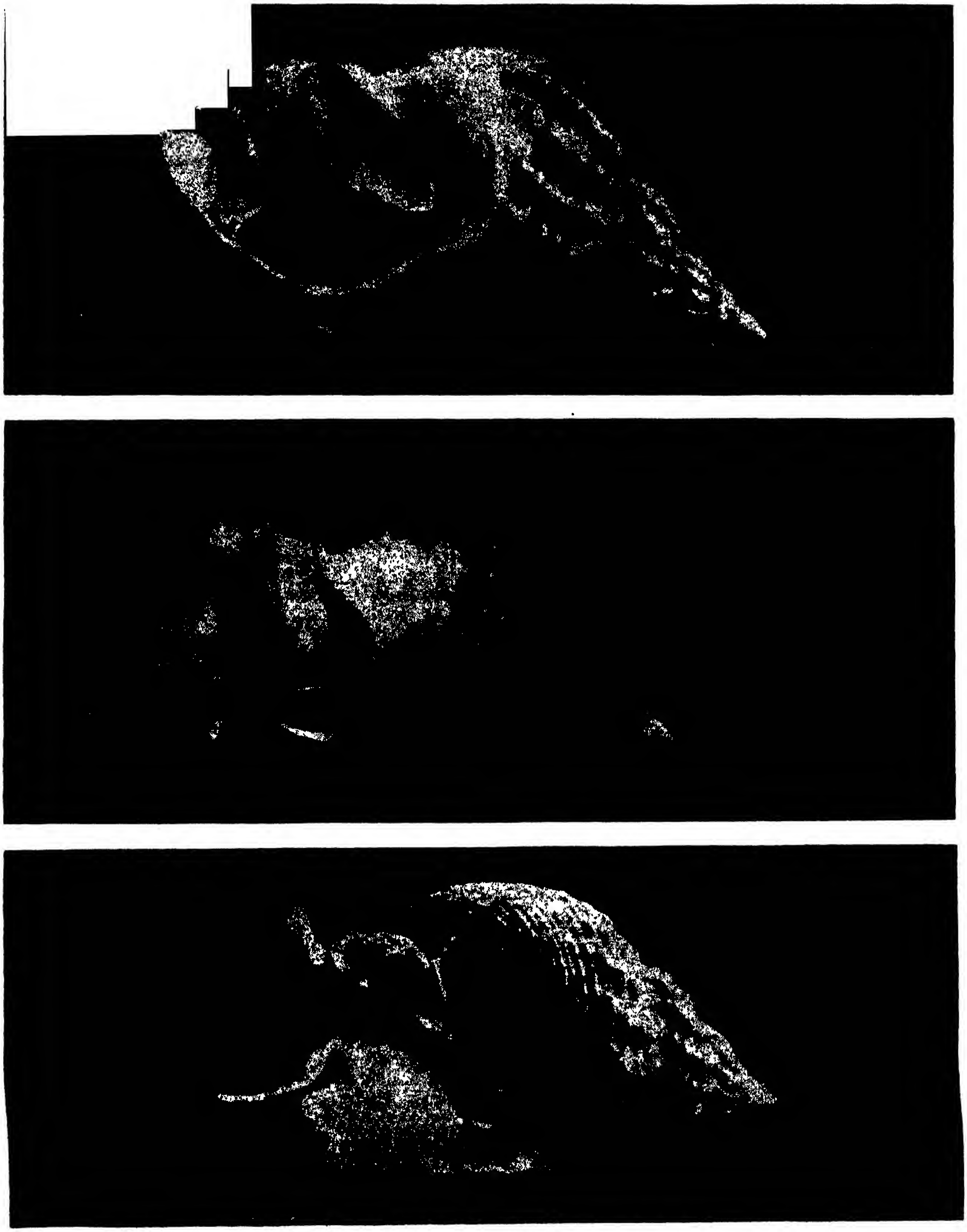
Some caterpillars move by making a loop of their bodies and so moving the claspers or "feet" on the hinder end of their bodies up towards where the fore claspers are, and then, while clinging with the hind claspers, move the fore part onward. Others move by undulating like the Cynthia given above. The lower photograph shows the clasper or pro-leg of a goat-moth caterpillar.

THE "swimming" of the jelly-fish is accomplished by the rapid and convulsive expansion and contraction of the disk-like body, which in its shape recalls that of an open umbrella. It is doubtful, however, whether we should attribute its progress to "swimming" since it is really borne along by currents and has no power of controlling its direction. The movements of the umbrella simply serve to keep it afloat. The beautiful Cydippe, looking like a crystal gooseberry, swims after a totally different fashion. Here the elongated body is beset with long bands of cilia, minute, "hair-like" structures, whose incessant movements keep the body at any desired level in the water, while long trailing tentacles serve at one and the same time for the capture of food and as balancers. The fact that one so often sees sandy beaches strewn with these frail bodies bears witness to the fact that they are all absolutely at the mercy of the currents.

Surely one of the most remarkable modes of swimming is that of the small crustacean, Phoronis—it has no name in common speech—which, with a little poetic licence, may be said to drive itself about in a barrel-shaped saloon car, made of the clearest crystal! The car is provided by one of the "tunicata" or sea-squirts.

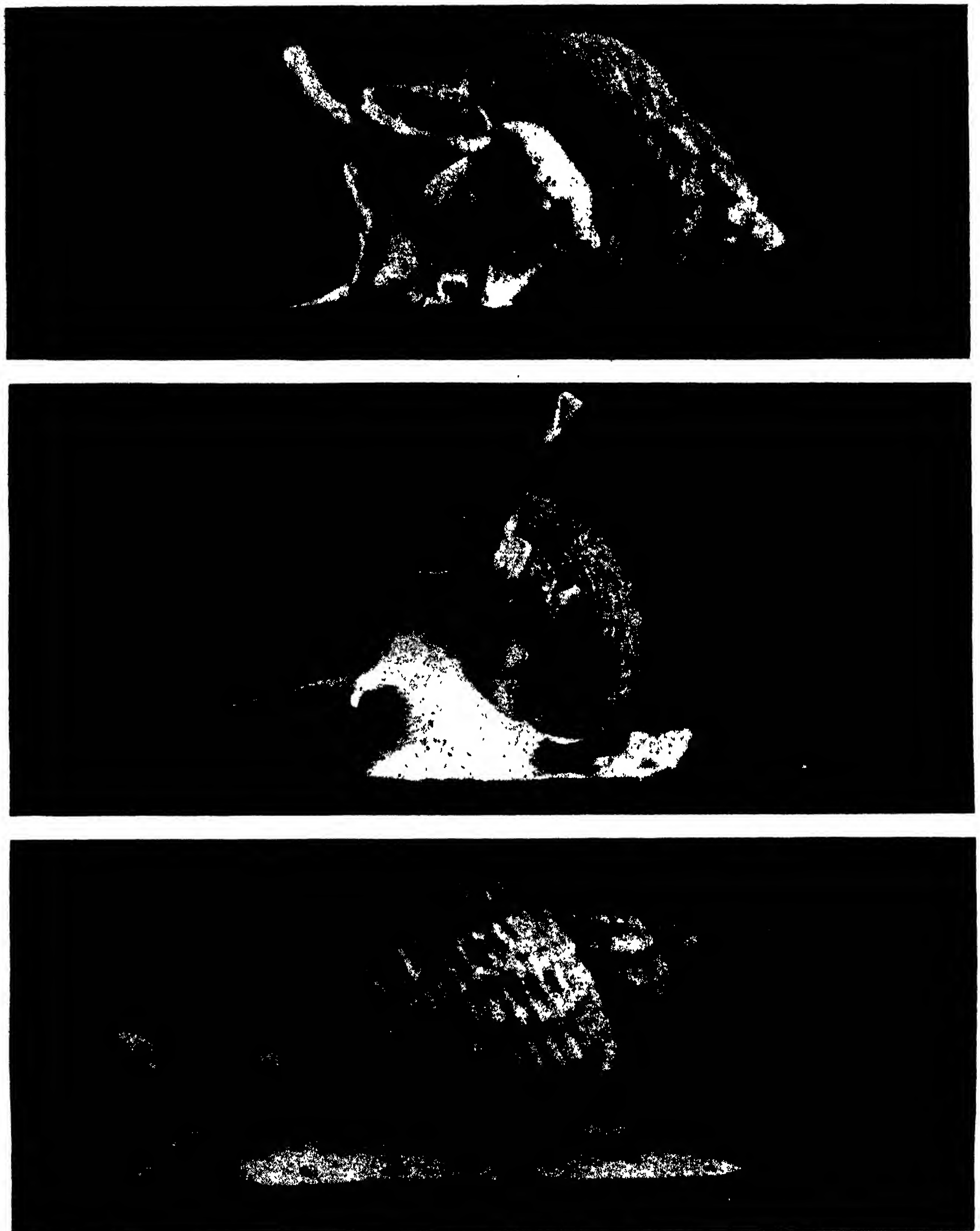
Phoronis instals itself within it, and by the movements of its "swimmerets" draws in a stream of water at one end and drives it out at the other, thus forcing itself and its strange carriage along!

The whale tribe have long since continued to do without legs as organs of locomotion—for the "flippers" answering to the fore-legs once used for walking, are mere balancers—yet they are amongst



HOW THE WHELK GRADUALLY COMES OUT OF ITS SHELL TO WALK—

When inside its thick protective shell the whelk guards itself from attack through the opening in the shell by closing that opening by means of a horny lid or operculum. When the whelk desires to emerge for the sake of shifting its position and the search for food, it opens the lid (top). Then the beginnings of the "foot" appear (centre) and begin to expand (bottom). The whelk, which is really a sea snail, is carnivorous in habit and preys on other molluscs by boring through their shells and then devouring the soft bodies inside.

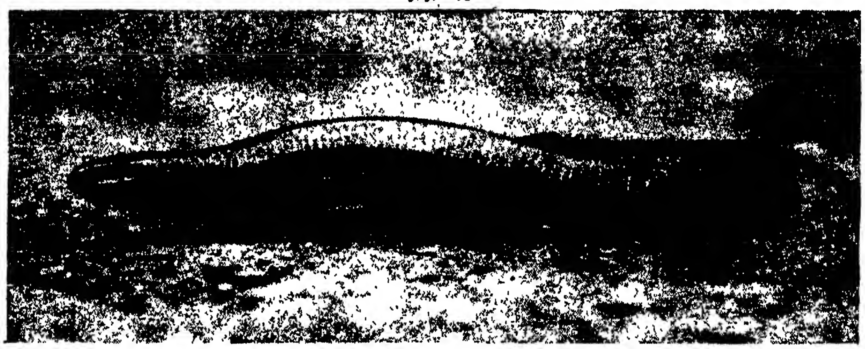


Martin Duncan

—THE UNFOLDING AND USE OF A VERY REMARKABLE KIND OF FOOT

These are the further and final stages of the whelk's emergence. The top photograph shows the broad foot with its edges still serrated because the unfolding is still only half complete, and the siphon breathing tube raised. The "foot" is then extended a little more (centre) and the breathing tube is now erect. Finally (bottom) the "foot" is fully expanded, and the wave-like motions are commenced which cause the whelk to move forward. Notice the operculum on the hinder end of the "foot." Like the snail the whelk has two horns.

J. J. Ward



W. S. Berridge

GLASS SNAKE AND SLOW-WORM, LEGLESS LIZARDS

In Russia, Hungary and in Southern Asia and North America there is a certain legless lizard called, erroneously, the glass snake. The legs are absent or very rudimentary, locomotion being achieved by means of the scales with which the body is covered. The slow-worm (top) also moves by the action of its scales, which are themselves actuated by the ribs.

the most powerful swimmers in the sea. To this end the whole body has become profoundly modified so as to offer the least possible resistance to the water, while the tail has developed a pair of enormous flukes spreading out, one on each side in a horizontal plane, therein differing, be it noted, from the tail of the fish, which is always set vertically. There is a reason for this.

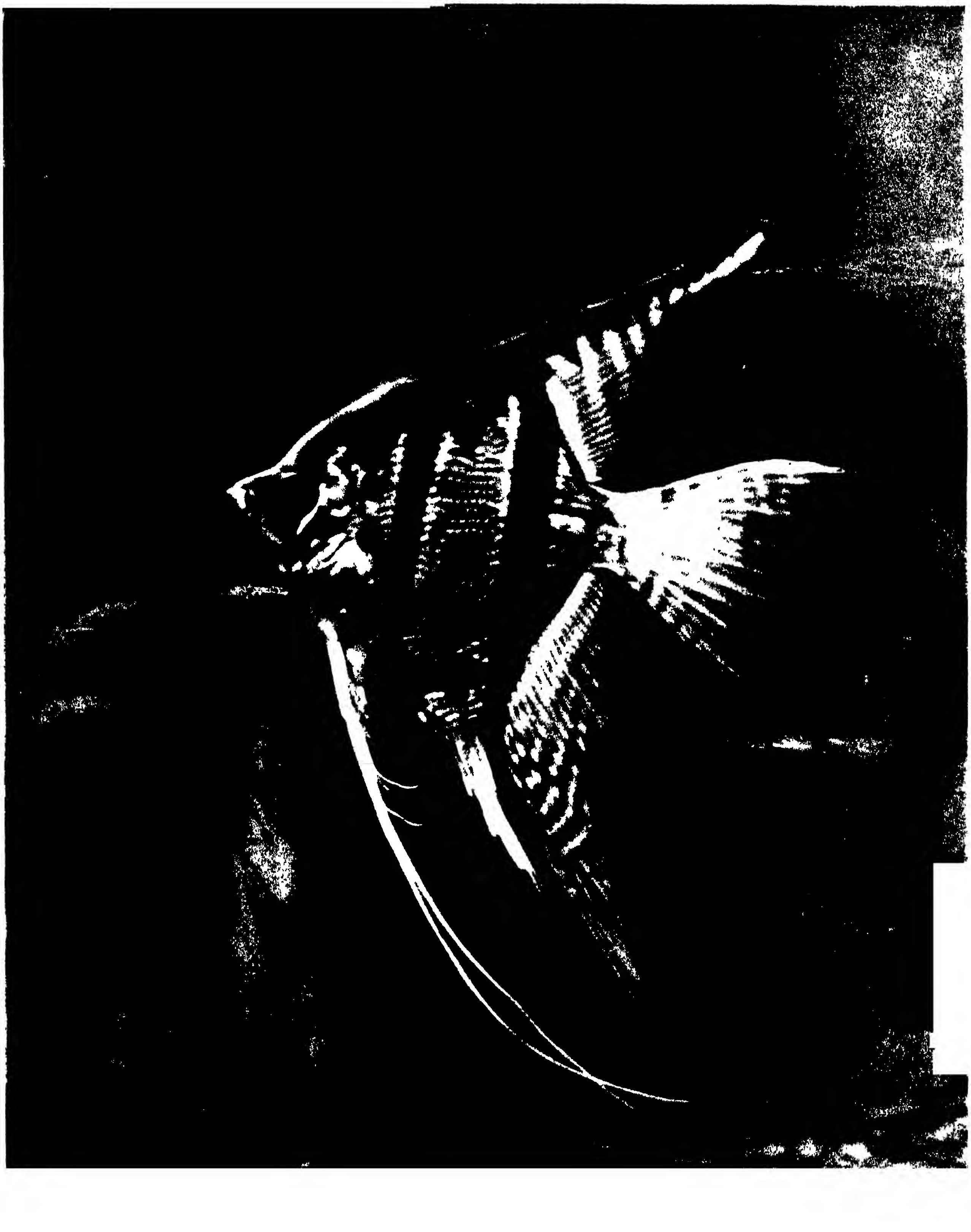
The whale, being a lung-breather, must come to the surface to breathe. The horizontal plane of the tail fin makes this easy, for its function is to thrust the body forwards and upwards for air, or downwards for food, with the greatest possible speed. The fish, being a gill-breather, has no special need to come to the surface; its tail being vertical drives it straight forwards. But this is not the whole explanation of the matter, for it must be noted that the method of using the tail is quite different in the two types. In the whale tribe the hinder region of the spine has to be moved upwards and downwards, instead of, as in the fish, from side to side.

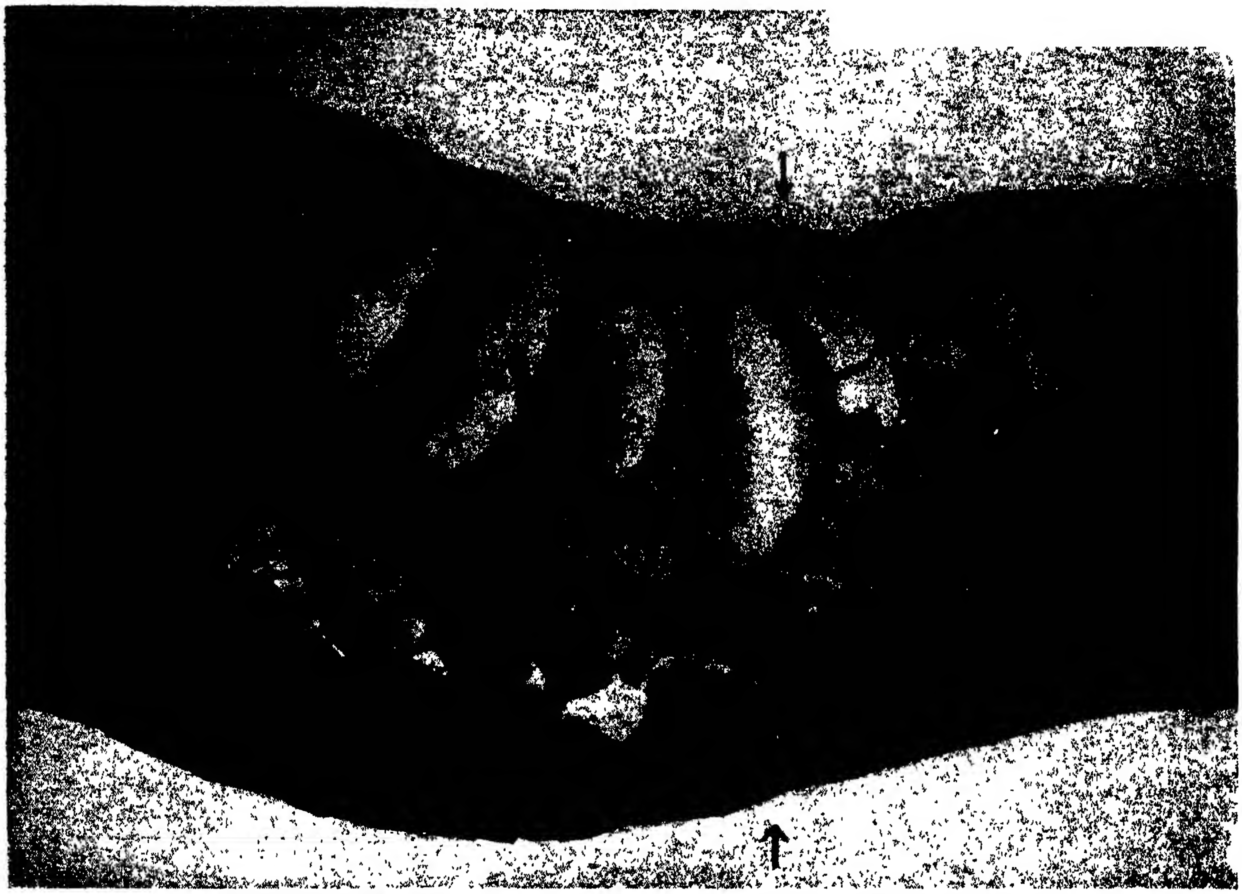
But the whales have had to conform still further to the demands of their fish-like life; at least, most of them have, by developing a back-fin to serve to steady them when going full-speed ahead. This fin, like the flukes of the tail, is formed only of fibrous tissue, and has no bony skeletal support as the fishes have. But such as swim in leisurely fashion have no dorsal [illegible]. Now we have a parallel to the whales—the manatees and dugongs, which also have developed whale-like, horizontal tail-flukes, but have no dorsal fin. They are, we know, very slow-moving. A further point of interest about them is that the river-haunting species have a great lobe-shaped tail-fin, while in the marine species this lobe has been produced outwards to form pointed flukes after the fashion of the whales. Whether these differences are due to the purely mechanical stresses and strains of the up-and-down movements or to a reaction to the different specific gravity of sea-water is a problem that is well worth investigating.

It is a very curious thing, but we constantly find that Nature, having, so to speak, gone to the trouble of fashioning bodies to "fit" some particular form of physical environment, is sure to remodel some of that type so as to attain the same general end by a different means.

Fishes, we have noted, swim by means of side to side movements of the tail, the end of which bears a fin, which alone, to most people, is regarded as the tail. But the sea-horse and the pipe-fish swim by a sort of wave-like or undulatory movement of the back-fin. There are, indeed, many species which swim after this fashion, and the most remarkable of all is the tropical Amphisile, which propels itself along by its dorsal fin, and head downwards!

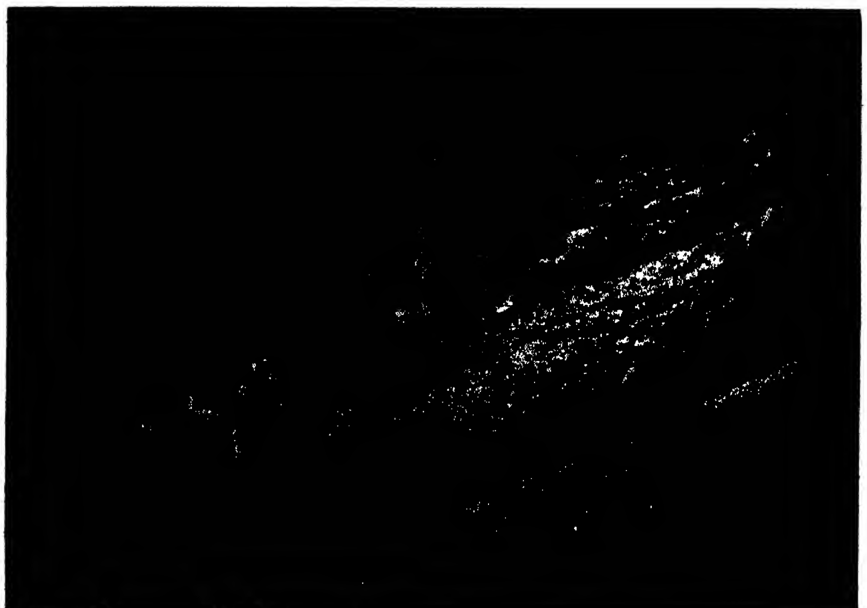
Let us turn, now, from the water to the air. Bats, birds, the old fossil pterodactyls, or flying-dragons, and insects of many kinds have fashioned themselves for long voyages in mid-air by means of wings,





though each type has achieved this end by a different method. Nature, however, has found the task, so to speak, of devising different means of traversing the upper air more difficult than locomotion on land or in the water. At any rate flying types are less numerous than running, leaping, climbing, and swimming types. But while some are remarkably efficient, others, it is to be noted, scarcely come within the category of flying-bodies: they might almost be called "Nature's experiments" so far as concerns flight.

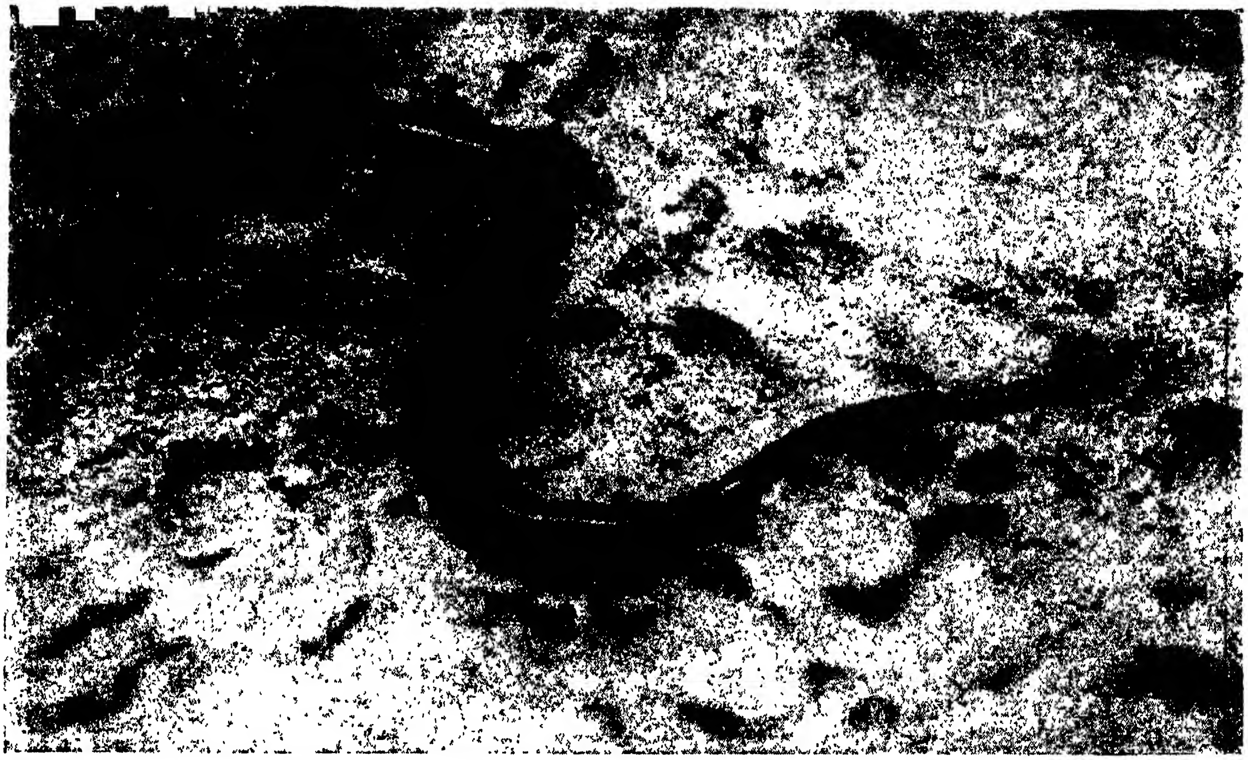
We speak of "flying fishes," for example. But here the flight is attained by an impetus gained from the water sufficient to carry the body well above the surface, when, by expanding a pair of enormously enlarged breast fins a temporary journey in mid-air is

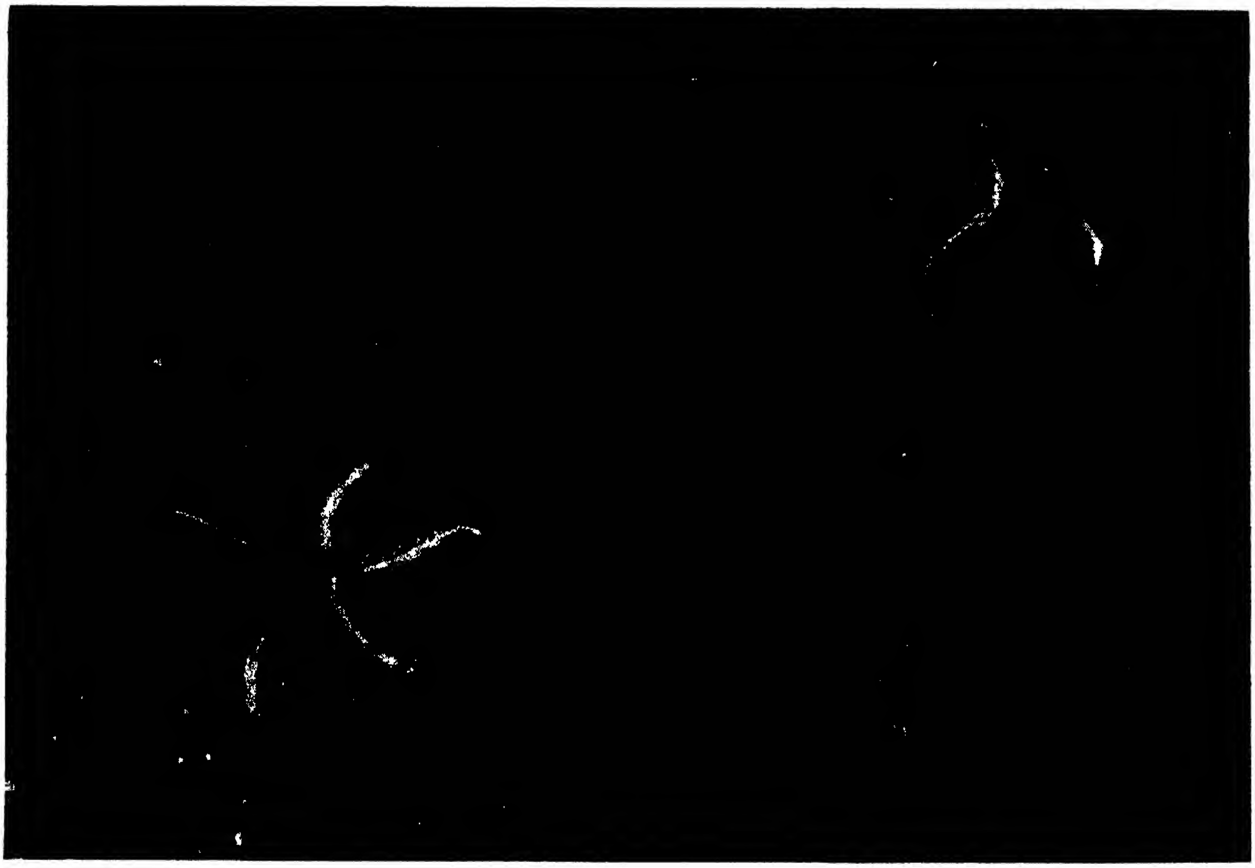


W. S. Berridge

PYTHON AND THE HOOKS THAT ARE REMNANTS OF LEGS

With the gradual dwindling of the legs which has accompanied the evolution of the snake, the body has correspondingly lengthened so that the spine has accumulated more vertebrae and each vertebra possesses a pair of ribs. These ribs function like the legs of a centipede but inside the skin. The skin of a python (bottom) possesses two hooks (top), remains of legs





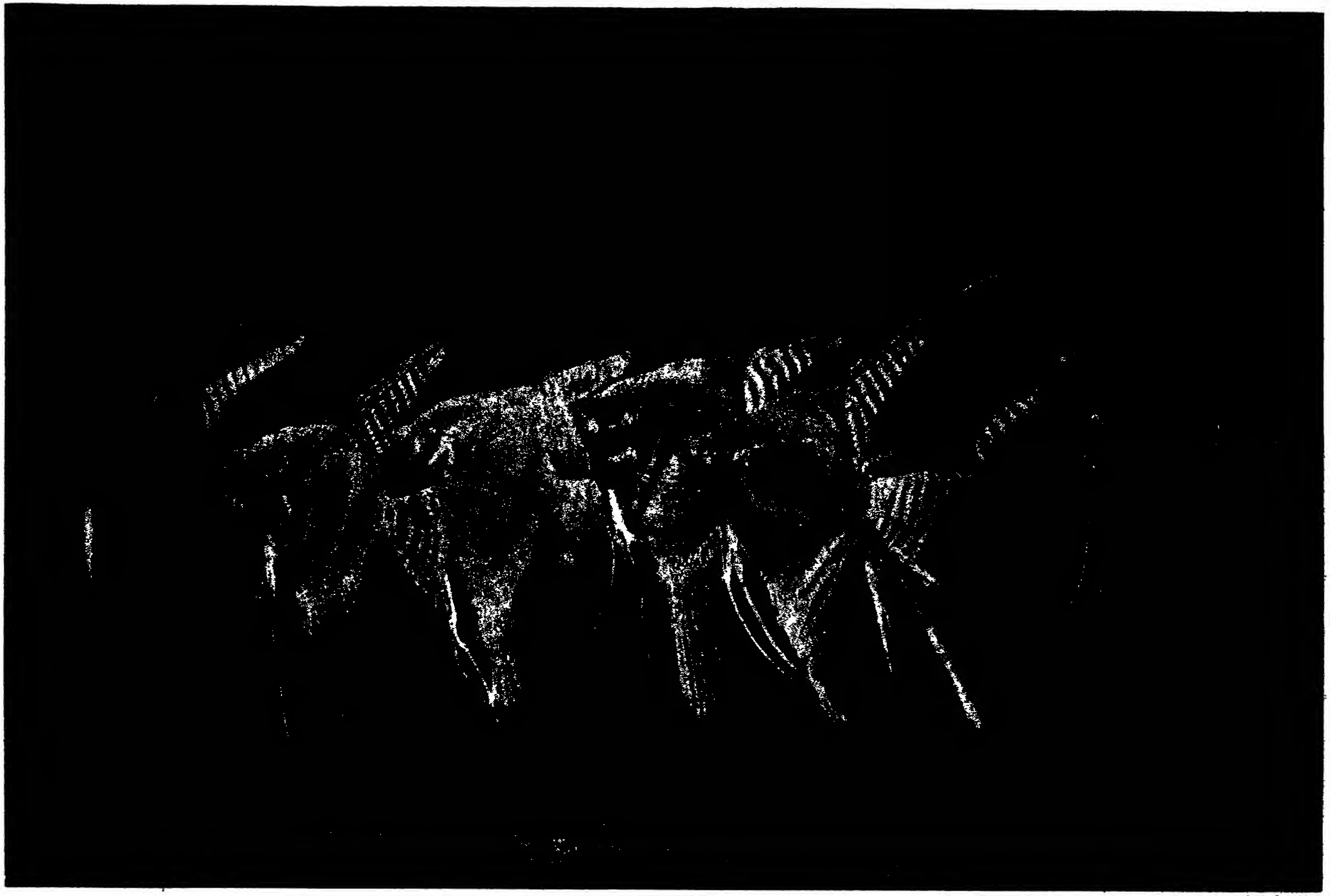
TRAIL OF A MOVING STARFISH IN THE SAND AND THE STRANGE SKINK

The rays or "arms" of the starfish are in no sense limbs but are merely incidental to one or other of the various shapes of body which the different species possess. These rays are covered on their underside with a great array of tiny organs which look to the naked eye like little columns of jelly. These may be seen to move, and they are, indeed, the sucker "feet" by means of which the starfish moves. Below is the track of a starfish and above is a skink which has no hind limbs and only rudimentary fore-limbs.

Shensky

WOLF FISH AND SLIME FISH, TRAVELLERS OF THE NORTH SEA

During the winter the wolf fish (bottom) comes into shallow water to spawn, and has been known to attack people wading with its sharp teeth which, in front, are conical and sharp-cutting and behind are adapted for crushing shell-fish. The slime fish (top) is one of the blennies, and with some other species is found along the British coasts. The photograph shows three females and two males, the latter distinguished by the forward part of their dorsal fins. The heads are furnished with tentacle-like growths and several rows of pointed warts.



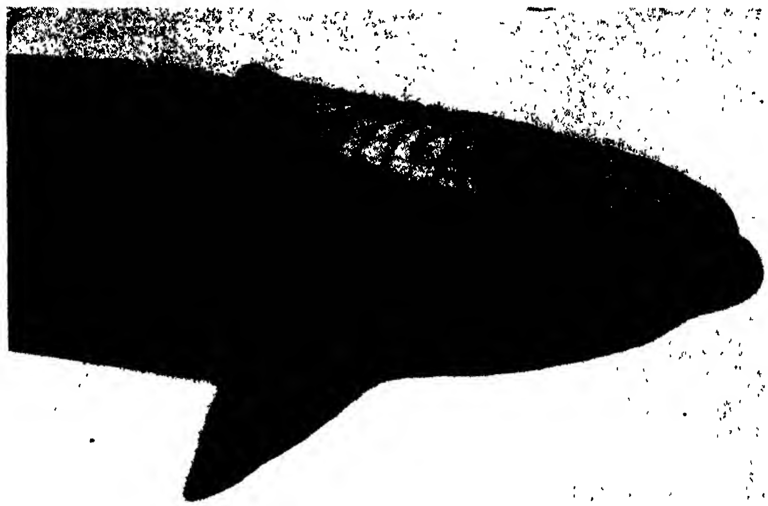
W. S. Berridge

A PAGEANT OF ANGEL FISH: TINTED SWIMMERS OF THE CORAL REEFS

In the clear, green-blue waters where they swim, illuminated by the tropical sunshine, the angel fish match or rival the hues of the surrounding coral reefs which are their home. The fins of this species are formed like the wings of a bird, and from the undersides of the body, near the lower jaw, project long, bony structures. These apparently serve the purpose of warning the fish when it is getting near the bottom or any projecting rock which might damage its brittle pectoral fin. These long, bony streamers that hang down far below the fin, are extremely susceptible to touch sensations. The angel fish's movement through the water has a beauty of its own unlike any flying or running in the animal kingdom.

possible, the " wings " serving as planes over a course describing an arc of varying length, depending on the initial impetus of the body and the force of the wind. Three quite different genera of fishes have attained to this interesting means of travel.

The so-called "flying-squirrels" do not really fly, but simply " plane " down from a height, descending in a long curve which may, for a short distance, become an ascending curve. Once launched in the air, however, no augmentation of the velocity derived from the initial jump and the force of gravity is possible to them.



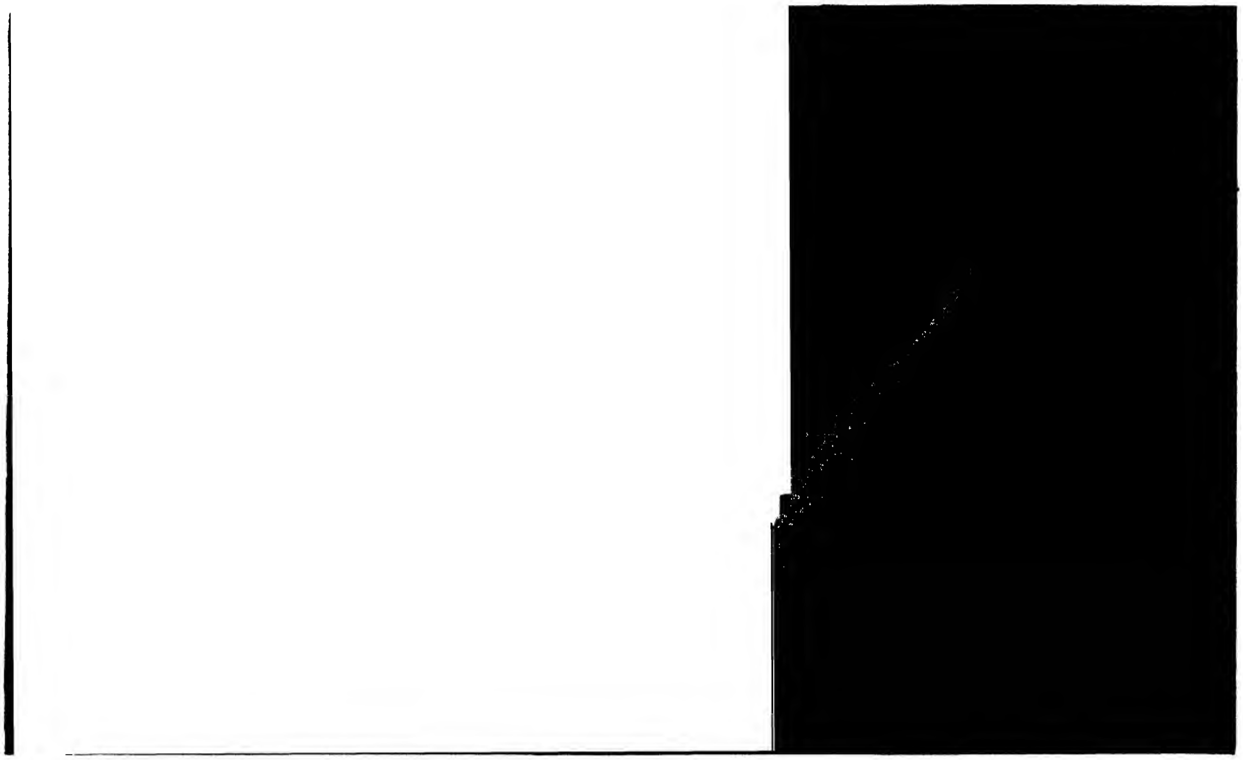
SUCKER FISH WHICH TAKES FREE RIDES ON SHARKS

Sucker fish have evolved, out of what in other fishes would be a spiny dorsal fin, a series of transverse plates, each plate being really an adapted spine of the fin. When the sucker fish wishes to visit another neighbourhood it swims up to a shark, presses its disk against the skin and raises the plates, thus forming a series of vacuum chambers by which it adheres.

In these animals a broad fold of skin extends along each side of the body to embrace the fore and hind limbs, so that when the legs are spread out in mid-air this fold stands out on either side, supporting the body after the fashion of a parachute. But one of the African flying-squirrels (*Anomalurus*) has effected an improvement, greatly increasing the area of the planing surface by means of a long, bony rod attached to the elbow. This, running through the skin-fold, extends it considerably beyond the wrist-joint, while at the hinder end this membrane is attached to the thigh between which and the tail an additional skin-fold is stretched, adding still further to the efficiency of the device.

The Australian " flying-phalangers " have developed a precisely similar device. Having regard to the fact that they are not even remotely related to the flying-squirrels this similarity is noteworthy. All these "planing" creatures it will be noted are tree-dwellers, like our common squirrel. That some should have developed this ready means of passing easily from one distant tree to another without descending to the ground is perhaps to be explained by a difference in feeding habits. For the ordinary arboreal squirrels feed largely upon nuts, most of which probably are picked up from the ground as they fall, hence, though they can leap from one tree to another when they are growing close together, they are not tempted to add to these leaping powers because the intermediate ground between two trees is always a potential feeding ground. Intensive effort always produces structural changes in the parts affected, as witness the tongue of the woodpecker and the whales. Birds probably inherited the potentiality for developing wings from some arboreal reptile-like ancestor which similarly, whenever possible, evaded a descent to the dangerous ground.

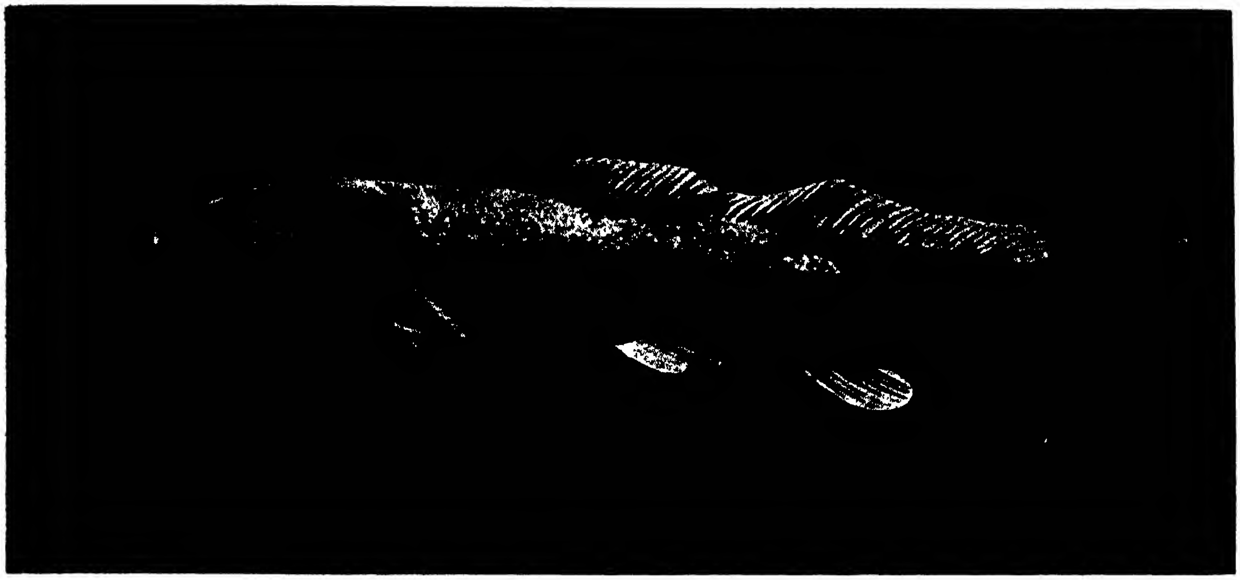
It is at any rate always, and only, in tree-dwelling types that we meet these " experiments of Nature " in the evolution of wings. Some curious examples are furnished by the reptiles. There are certain Bornean tree-snakes which take flying leaps from tree to tree, supporting themselves in mid-air by drawing up the belly till it nearly touches the backbone, thus the body, held stiff when taking its arrow-like flight, resembles a split bamboo. The channel thus formed apparently affords a " grip " of the air which gives a steadying action, and helps to maintain the direction of the flight.



Martin Duncan

THE RAY SWIMS BY UNDULATING MOVEMENTS ALONG THE SEA FLOOR

The ray is a fish, yet it hardly uses its tail for propulsion. Its family is an offshoot from that of the shark, and in the course of its adaptation to a life on the bottom of the ocean it has modified its pectoral fins so as to form a fringe round its body. The ray swims by a series of undulations which involve the whole body, but are most marked at its edges, where the fins have a positive rippling motion. The lower photograph shows the whitish underside and the upper the swimming movement.



Neville Kingston

AMERICAN BOWFIN AND ITS STRANGE WAY OF SWIMMING

The bowfin is the only representative of its order now in existence and it lives in the Great Lakes of America and also in the lakes of the Mississippi Valley. The dorsal fin is very elongated and low, and the fish moves by undulating this specialised fin. It is a sluggish creature and has little need of any great speed such as those fish have which swim with the tail. The movement of the fin, rippling gently over all its flexible length is very fascinating to watch through the glass of a zoo aquarium.

Some of the geckoes have a fringe of skin down each side of the body recalling that of the flying-squirrels, but it does not extend on to the limbs. Some authorities regard this fold as a sort of "flying-membrane," others hold that it serves merely to obliterate the animal when clinging to a tree-trunk, by blending the contour of the body with that of the tree. But be that as it may, we have a clear case of a "flying-membrane" in the Malayan "flying-dragon" (*Draco volans*), and this of a very singular type. For in this creature a great fold of skin is extended on each side of the body by means of the hindmost ribs, which are here produced into long, slender rods sweeping outwards for a considerable distance. As the creature takes its plunge into space the ribs are thrust outwards and forwards, spreading out in great and gorgeously coloured wing-membranes. But when at rest the ribs fold backwards, and the body assumes a singularly "starved" appearance.

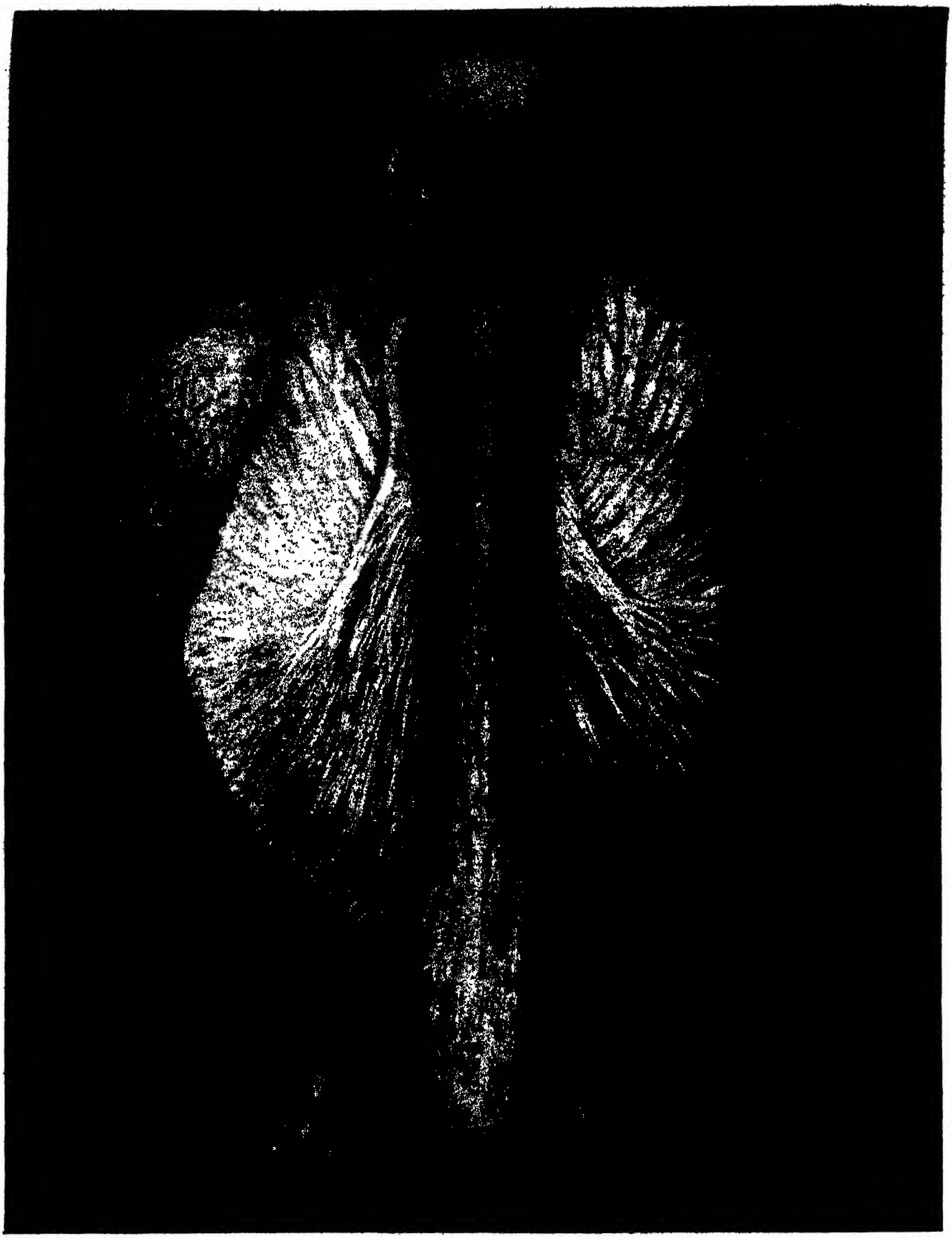
Borneo has a frog which "flies"! And here again it is a tree-frog. The toes, both of the fore and hind feet, are unusually long, and connected by a web. By spreading these when in mid-air a very considerable surface of resistance is offered to sustain the body till its goal is reached.

Let me turn now to one of the strangest modes of aerial travel in Nature. This is furnished by the spiders, which contrive to make most extensive travels in mid-air without undergoing the slightest modification of their bodily structure to do so.

On calm summer mornings, either of early summer or late autumn, the grass, railings and bushes may be found covered with a delicate carpet of silk, revealed by the dew. And moving about among this maze of threads you may have the good fortune to see what looks like a race-congress of spiders which, for once, have thrown aside their cannibalistic moods for the attainment of a common end. All sorts and conditions are here—wolf-spiders, crab-spiders, jumping-spiders, and the tiny black Therdiid spiders. But they are all small, some being adults, while some are the young of the larger species.

With great good fortune you may see what the gathering means; for you may see one of this crowd holding fast by the silken threads, raising up the fore-part of the body, then turning the abdomen skywards. Presently the spinnerets eject liquid silk, which is caught by the gentle breeze and borne upwards. More and more of this silk rope is "paid out" till at last the spinner begins to feel the pull of the rope. He then releases his hold and is promptly borne upwards to a distance of sixty, perhaps a hundred, feet, and away he goes on his travels. If he desires to end his journey he hauls in the rope with the hind legs, rolls it into a ball, and carries it near the mouth.

This is the phenomenon known as "gossamer" which so puzzled Chaucer and Spenser, Quarles and Thomson, to whom these filmy floating threads were a mystery. Martin Lister, so long ago as 1670, was the first to solve the riddle. He observed the wonderful flight from the highest point of York Minster, whence he could discern these little travellers "exceeding high" above him. Darwin found them at sea, during the voyage of the Beagle, sixty miles from land! Gilbert White describes a "shower" of these little aeronauts descending from their travels. It extended over an area eight miles in length. In this way not only is overcrowding effectually evaded, but the range of the species is also hereby extended



THE RESTING PELICAN: AN EXAMPLE OF NATURAL SYMMETRY

"Stream-lining" has been developed in Nature to a fine point as may be seen by studying the body of a fish or bird which is designed to offer the least possible resistance to the medium—water or air—through which movement has to be made. This utilitarian construction of shape gives us also a design of artistic excellence. Notice in this pelican how wing balances wing and how, with the head feathers which, as a whole, resemble a lawyer's wig, one side balances the other; and yet none of these features possesses an exact measured equality.

Chapter LVIII

Form and Design in the Animal Kingdom

By Stanley T. Burfield

Lecturer in Zoology, Liverpool University

When we speak of beauty in an animal we are more often than not referring to its colour or to the distribution of this. Sometimes movement or general form is spoken of as beautiful, as when we admire the litheness of a cat or the gracefulness of a swan. It is to be noted, moreover, that it is in the higher types of animal life that the average man finds beauty. This is natural, because these higher types are those which most often come within general knowledge. Geometric form and design are not so obvious in these, though closer study often shows beautiful adaptation of form to habits.

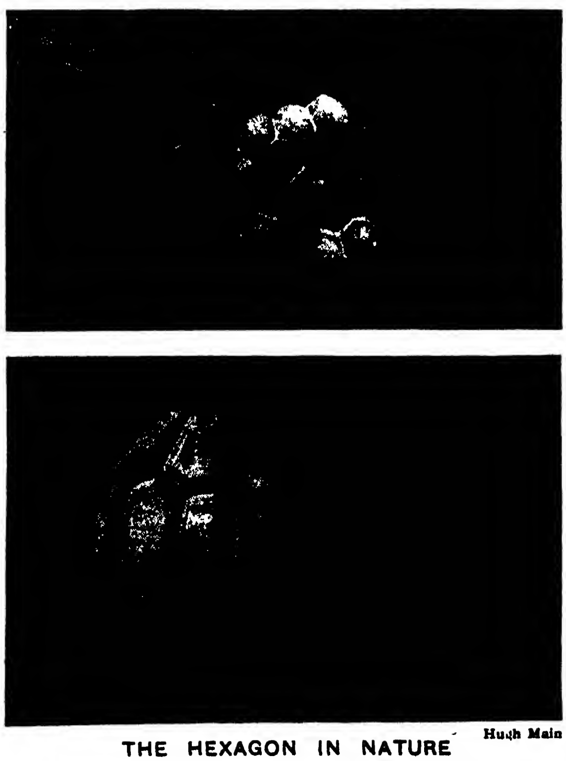
More regular geometric form is found principally among the lower and less well-known kinds of animals. Why is this? There are various reasons. Such regular form is often to be seen among very small animals whose bodies are composed of soft semi-fluid living matter, and the shape of these is more easily directly controlled or influenced by purely physical factors acting in a symmetrical manner. In some larger types of animals, however, a geometrical form is developed by a peculiar manner of growth, as in many shellfish.

All animals grow during some period of their lives, but the general manner of growth is different from that seen in inorganic material such as a crystal. The latter may increase in size, and this is brought about by the addition of further material to the surfaces of the original crystal. The animal, on the other hand, grows by the adding of further living matter within the original body. The result of the first method is often perfect geometrical form with sharp edges and plane surfaces. The latter way of growing, however, tends, with the semi-fluid consistency of living matter, to result in curved surfaces, and straight edges and plane surfaces only appear in connexion with some of the solid dead material produced by the continued activity of the living substance.

Animals being solid bodies, their form would have to be described strictly in terms of solid geometry, and we should perhaps have cone, sphere, tetrahedron, cylinder and so on. In surface view, however, there would often be recognized plane figures such as circle and hexagon. It must therefore be remembered that if such terms as the latter are used only a surface view is being described.

Many of the most regular and beautiful geometrical forms are found among the smallest known animals, the protozoa. The bodies of these are made of a small mass of semi-fluid living material, protoplasm. An important physical phenomenon which has a profound effect on their bodily form is "surface tension." This is a property of liquids, and is that force which is shown at the surface where the liquid is in contact with another liquid, solid or gas. It is the force by which we can explain the shape of a drop or bubble and of a number of other forms of a similar nature. Whilst this surface tension is an extremely important factor in the moulding of form in the case of the simplest organisms, the final shape also depends on various other phenomena such as gravity and mechanical pressure. For a liquid film in equilibrium surface tension results in a tendency for the surface area to be reduced to a minimum. Where a small portion of liquid is subject only to the forces of its own particles, this tendency accounts for the assumption of a spherical form, as in the case of a raindrop or the body of many simple organisms, because the sphere, of all solids, has the smallest surface for a given volume.

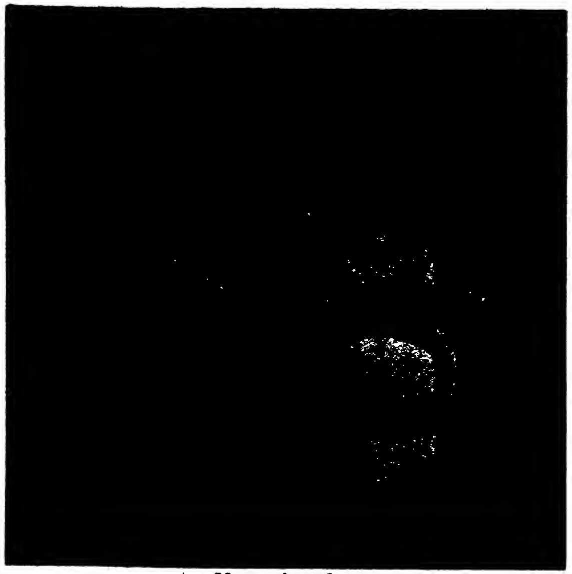
Thus the protozoa belonging to the sub-divisions radiolaria and heliozoa are very often in the form of perfect minute spheres. In other cases there has been some form of pressure or restraint during the development which results in a modification of the simple spherical form. This restraint is most constantly found in the partial or complete solidification of the cell wall. Even among the protozoa, then, there is a great variety of form.



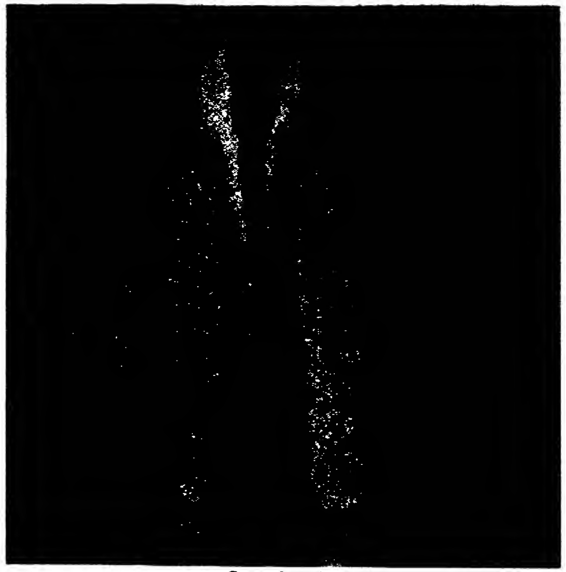
Hugh Main

THE HEXAGON IN NATURE

An explanation of the constant appearance of a hexagon or six-sided figure in Nature is that this figure or shape is due to uniform deformation under pressure. Here we have a tortoise's shell (bottom) and the cell of a wasp (top).

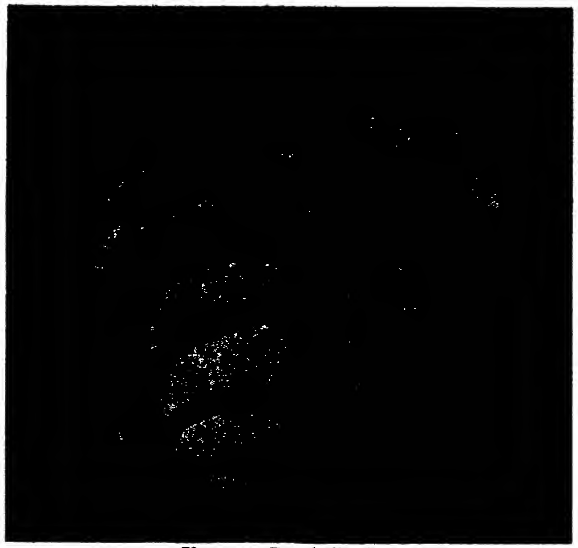


Mountain zebra



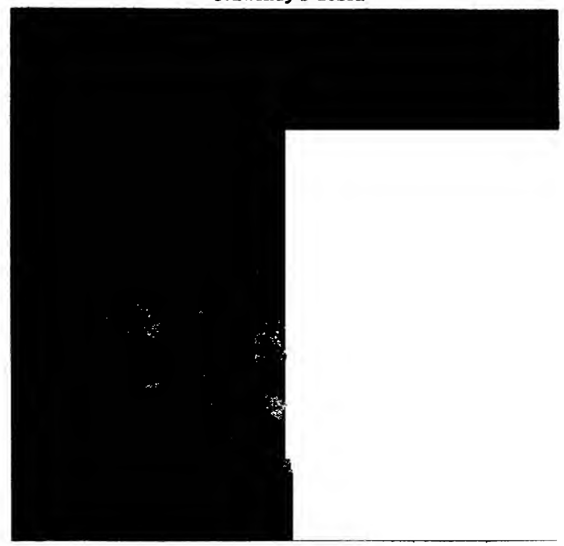
Grevy's zebra

Crawshay's zebra



Chapman-Burchell zebra

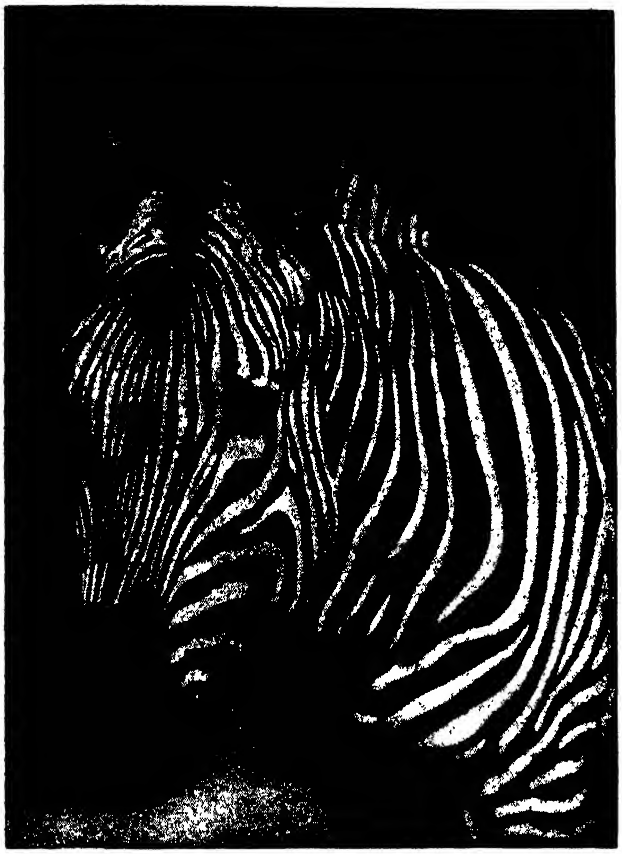
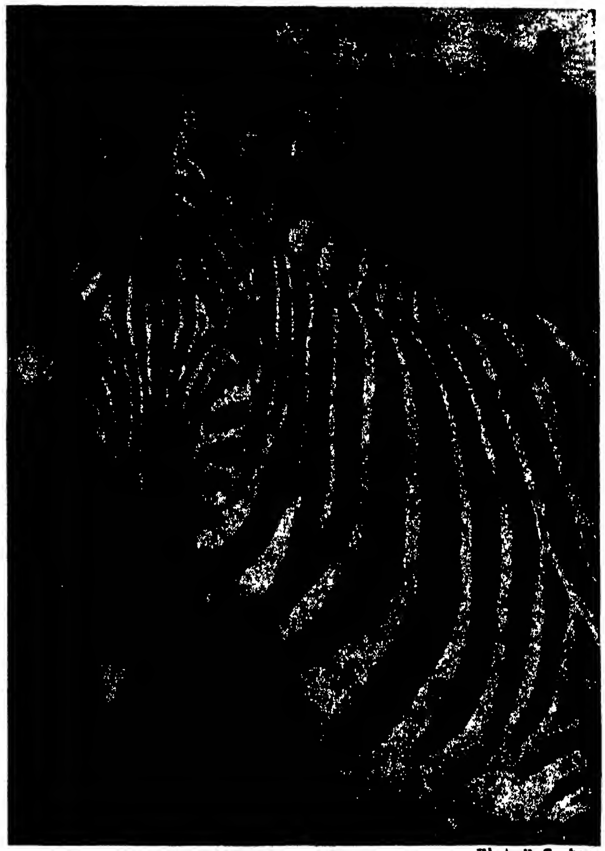
Shadow stripes on a Chapman-Burchell zebra



Hartman's zebra

WONDERFUL VARIATION OF STRIPES AND BARS IN THE HIDE OF THE ZEBRA

While a cursory glance might suggest that one kind of zebra was much like another, yet a closer inspection will reveal that this, so far as markings are concerned, is far from the case. The variations in arrangement of the bars of black, and stripes of tawny-white are considerable and intricate. Compare the markings of the true or mountain zebra (top left) with those of the Grevy's zebra (top centre). The former comes from South Africa where it was formerly almost extinct but is now increasing under protection. Grevy's is the largest of the zebras and stands as high as a horse. The hind quarters of a Chapman-Burchell zebra (bottom centre) are, again, quite distinctly marked. The photographs are by Elwin R. Sanborn.

HANDSOME HEADS AND FOREQUARTERS OF THE ZEBRA

Elwin R. Sanborn

Zebras seem to prefer thinly wooded and open country to forest or dense bush, and are specially adapted for a life among rocks and arid plains. But they keep within a few hours' travelling of water. The markings vary greatly, not only with different species but also with individuals. Not even the tiger can outdo some of the zebras in the magnificence of stripes which seem, so far as investigation has gone, to be an inheritance from some remote ancestor of both horse and zebra.

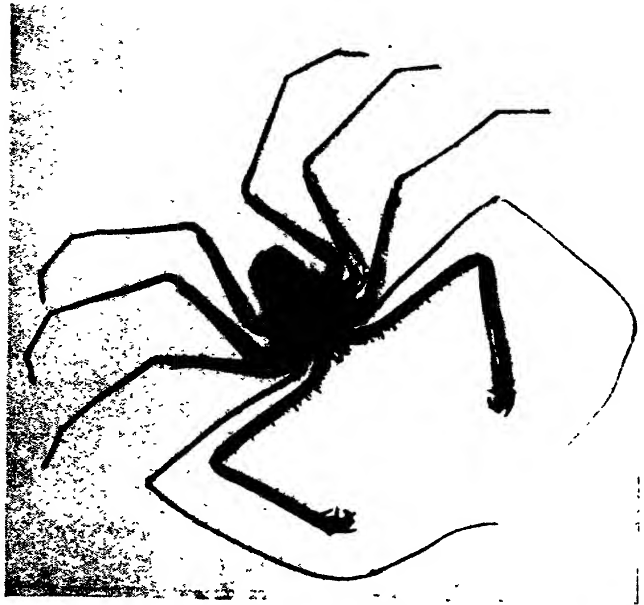
The amoeba is quite an irregularly shaped mass of semi-fluid protoplasm, and its shape as a whole certainly does not conform to one of the types known as surfaces of minimal area. The surface is not, however, an equilibrium surface at all, and the living cell is not itself in any stable equilibrium, but each portion of the surface is constantly changing its form. Those unicellular organisms which rest in stable equilibrium have a shape which either conforms to the conditions imposed by surface tension alone or is the result of some kind of restraint imposed upon the ordinary surface tension.

Among the infusoria some are distinctly spherical, as in the small flagellate monads, but even here they are usually only truly spherical whilst in a "resting" or encysted condition. When a flagellum is developed, we have signs of an unequal tension of the outer membrane, and the end of the cell is drawn out into a tapering point.

A large number of infusoria represent "surfaces of minimal area" in their form. The cups of various vorticellas are a beautiful series of such surfaces. We find every gradation from a form all but cylindrical through a series of unduloids or partial unduloids to an almost perfect sphere. The cylinder, unduloid and sphere are all surfaces of minimal area. In other cases, such as in the various species of tintinnus among the ciliata, we find a similar series of shapes exhibited by a membranous cup which is separate from the animal but was originally moulded upon its semi-fluid living surface. A curious little ciliate called trichodina has a most peculiar shape. It may be compared roughly to a short dice-box, the lower surface being plane and the upper one may be either plane or slightly concave. When the upper surface is plane the equatorial groove forms a surface of minimal area called a catenoid; when the upper surface is depressed the groove tends to assume the form of another minimal area surface, the nodoid.

Among the foraminifera there are great varieties of form which are capable of explanation in the light of surface tension and the principle of minimal area. Many of these protozoa are composite structures formed by the development of a series of calcareous-walled chambers. Some of these are complicated, and we shall glance at a few of the single-chambered and simplest composite varieties.

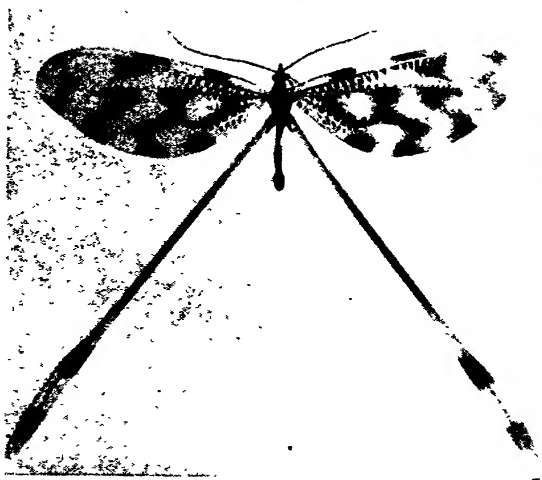
In orbulina we have a perfectly symmetrical sphere. Most of the single-chambered calcareous foraminifera belong to the genus lagena. These



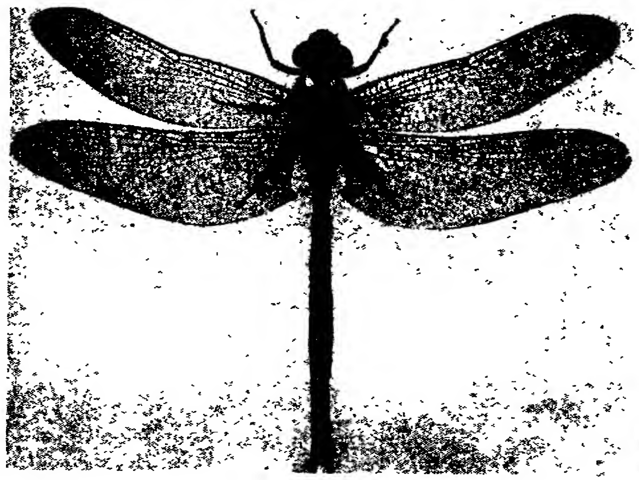
African whip scorpion

Central American chafer

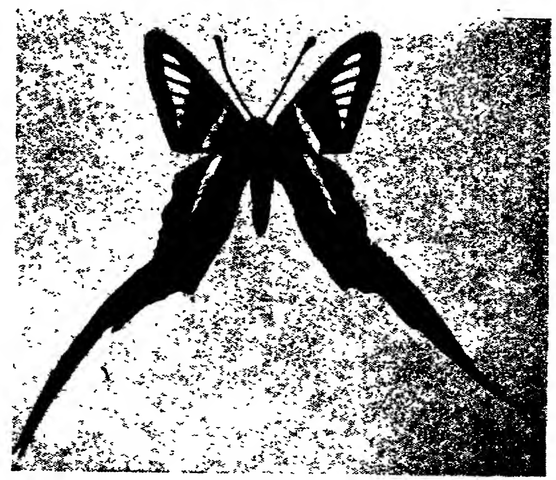
Brazilian leaf grasshopper



Syrian neuroptera



Large dragon-fly



Butterfly of Assam

SHAPES AND STRUCTURES BEAUTIFUL AND GROTESQUE OF NATURE'S FASHIONING

Nature usually makes her creatures beautiful or repulsive or terrifying not only in detail, but also in general design. The African whip scorpion (top left), for instance, seems made to be shunned. The shape of its legs and of the angular pedipalps which serve much the same purpose as the claws of the lobster, and the formation of the rough-looking body, are all designed apparently to make man and beast turn away. On the other hand, the creative power seems to have gone as far in the opposite direction when evolving the form of the winged beauty seen in the lower left-hand photograph, or in the butterfly from the forests of Assam (bottom right). These photographs are by Martin Duncan and H. Bastin.

are beautiful flask-shaped forms whose surface is simply an unduloid or an unduloid combined with a portion of a sphere. These shapes suggest hanging drops drawn out into slender necks by their own weight. Many of the lagenidae have a beautiful reticulated or ridged pattern on the shell, which is probably developed by local shrinkage and changes of surface tension in the outer layers of the protoplasm before the hard shell has fully developed.

Neville Kingston

LOVELY MOON MOTH OF AMERICA

Here we have an example of one of Nature's most exquisite designs where the form as much as the colour gives the creature its beauty. This is an American moon moth, and we see it here newly emerged from its cocoon into the sunlight, which is slowly drying the pale green wings. The long "tails" hang down like delicate draperies to bedeck an already lovely creature.

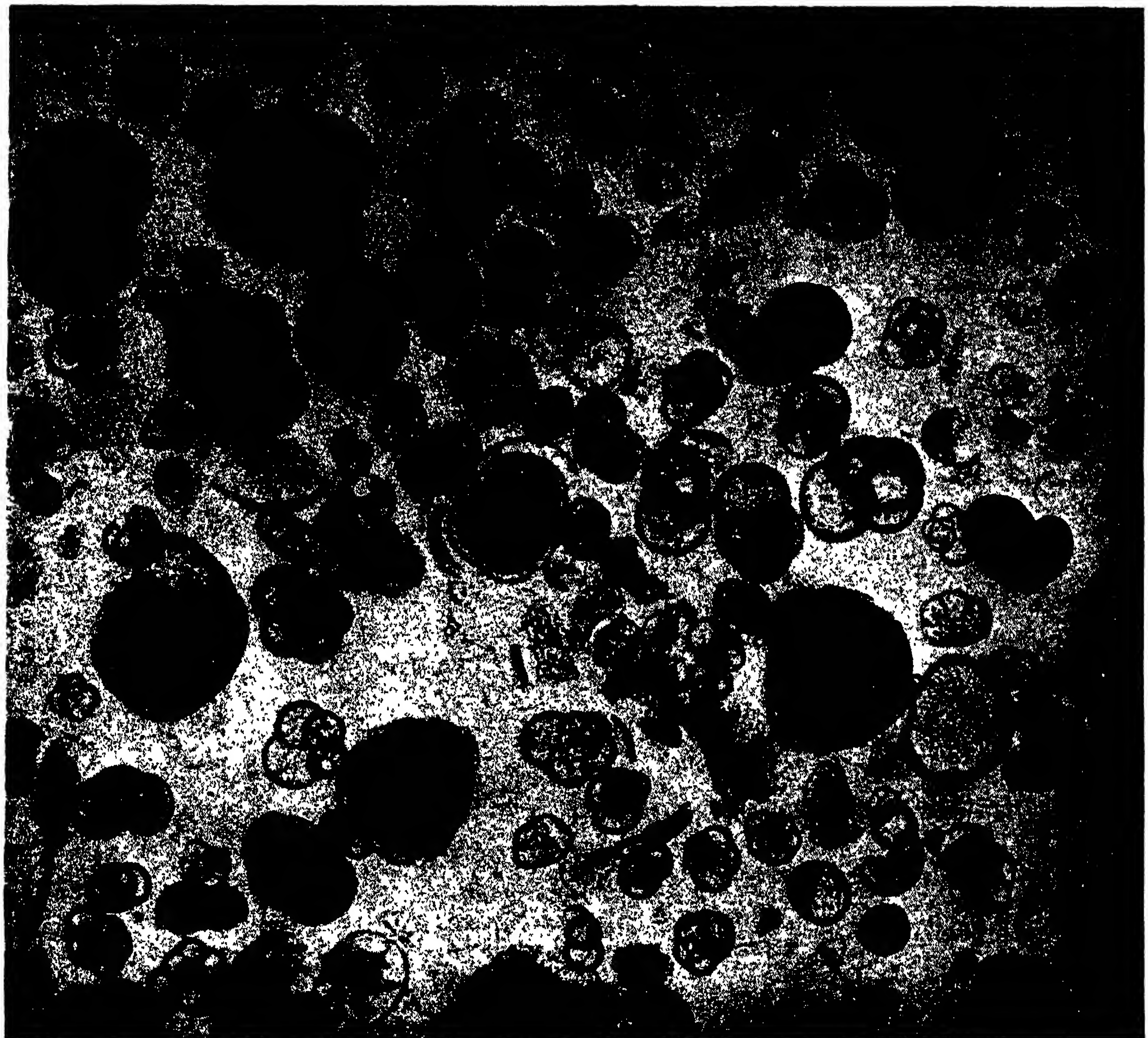
ANOTHER series of foraminifera composed of a number of chambers is seen in the species of nodosaria and others. In some of these, rheoplax, for example, with a sand grain covering, we have cases of segmenting or partially segmenting cylinders. Under surface tension forces it can be shown that a cylinder is only a surface of complete equilibrium when its length is not greater than its circumference. If a liquid film in the form of a cylinder be drawn out, it is found that when the length becomes greater than its diameter it changes its shape, passes into an unduloid form and ultimately breaks into two spheres. In other cases we can see by examining the interior of the shell that it has been formed in successive stages. First a simple unduloid "lagena," and then about the neck of this, after solidification, another drop of protoplasm has accumulated and in turn has taken on the unduloid shape.

The hexagon is to be found frequently among the lower forms of animal life. We can explain the appearance of this polygon in many cases fairly easily. If we imagine a system of equal cylinders or spheres in contact with one another in a plane, they will be represented in section by equal and touching circles. Now simple geometry tells us that each circle will be in contact with six surrounding circles. If we now imagine the system of spheres or cylinders to come under some uniform pressure the points of contact between the circles will be extended into lines of contact and the equal circles will become regular and equal hexagons.

These considerations will hold true not only for individual cells in the body tissues, but for any closely packed bodies of uniform size and originally circular outline in section which are of such a consistency as to be capable of uniform deformation under pressure. Thus a hexagonal pattern is of very common occurrence and is to be noticed under very varying circumstances.

The corals show us various examples wherever the coral animals or polyps are packed close together. The originally cylindrical soft-bodied polyps become squeezed into hexagonal prisms and the secretion of the chalky outer skeleton over the side walls of the prisms takes the hexagonal form which therefore becomes permanent.

PERHAPS the best known of hexagonal structures connected with animal life are the cells in the comb of the honey bee. These cells are in two layers, the cells of each layer being placed end to end. An inspection of either surface shows at once the hexagonal outline of each cell. The explanation which we have already given of the hexagonal form assumed by closely packed cylinders doubtless holds here.


E. H. Botting

SHELLS OF GLOBIGERINA FROM THE DEEP SEA OOZE

These shells which serve to protect the minute creatures called globigerina (that belong to the division Perforata in the order Foraminifera) are found in great numbers in the ooze covering much of the sea floor. They have gone in their accumulated millions to form part of the chalk deposits which, once at the bottom of the sea, now form the subsoil of the cliffs of many miles of English and French territory. So thick is the deposit of this particular kind of shell in some parts of the ocean bed that it is called "Globigerina ooze."

The wax when first produced by the bee in the warm hive is in a semi-fluid condition. The bee fashions a cylinder and packs it as close as possible to the cells already made. The efforts of the bee in close packing are probably not sufficient to produce the even smooth-sided hexagons which finally result, but it is more than likely that the wax being at first in the form of a thin semi-fluid film, surface tension comes into play between adjacent films, and these symmetrical tensions result in the regular form assumed by the gradually hardening cell walls. It is to be noted that the portions of the queen cells which project freely above the level of the others and are therefore not under lateral pressures or tensions are of a cylindrical form. [The Editor would draw attention to the fact that on this point of the formation of hexagonal cells the Rev. Tickner Edwardes in his chapter on "The Wonderful Commonwealth of the Bee" suggests another explanation. See Volume I, page 257.]

The explanation given is sufficient to cover the hexagonal form as seen at the open ends of the cells of the comb, but the whole cell is more complicated in shape. The point of further interest is the form of the closed ends where the two layers of cells are in contact. Under surface tension forces, a fluid cylinder in equilibrium has a symmetrical end in the form of a portion of a sphere. Now if we can manage to make an imaginary picture of these

E. H. Botting

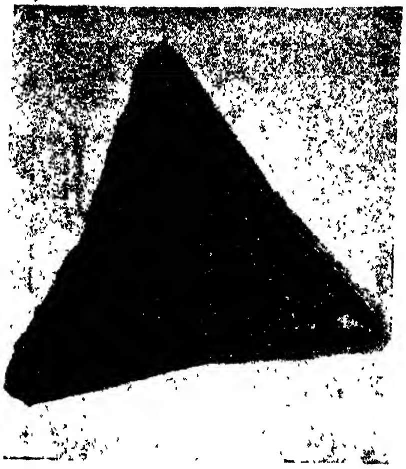
WONDERFULLY FASHIONED SKELETONS OF THE RADIOLARIA

The hard skeletons of the animalcules known as radiolaria are built up into the most amazing complications of shape and design. While alive some of them float on the surface of the sea, their jelly-like bodies aglow with yellow, crimson and blue, while others live at varying depths, and, when dead, their beautiful skeletons sink down through the dark fathoms to rest on the bottom of the sea already thickly covered with the " bones " of their brethren. The shells above came from Barbados where large deposits of radiolaria are found.

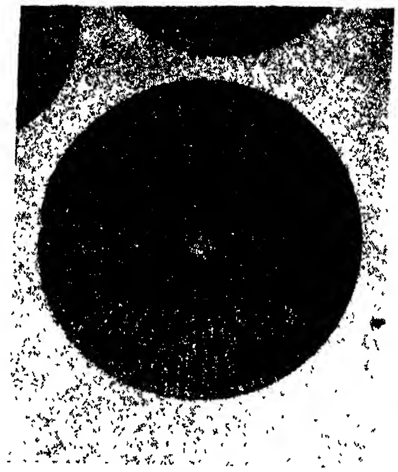
inner partially spherical ends of the two layers of cells fitting close against one another, we shall see that each will fit in between three others. By mutual symmetrical pressures the spherical end of any one cell will be pressed by its three neighbours so that the end will take the form of a solid trihedral angle with three meeting edges. This three-surfaced end is fitted on to the six-edged hexagonal prism by planing off every other angle of the prism regularly. Thus the closed ends of the prisms are tapered off to a point and all fit together without intervening space. This is found to be the shape of the closed end of a bee's cell. If both ends of the prismatic cells were closed in this way we should have the regular twelve-sided solid called the rhombic dodecahedron.

When we consider the general body shape among the more advanced types of animal life simple geometric form becomes much less frequent. The reason for this has already been indicated. The larger and more complex bodies are not so directly under the control of the simpler external physical forces. The play of these forces, such as surface tension, is, however, still to be seen in the form of the cells in various tissues of such a large animal, and also in the whole animal in its earliest embryonic stages in which it consists of comparatively few cells.

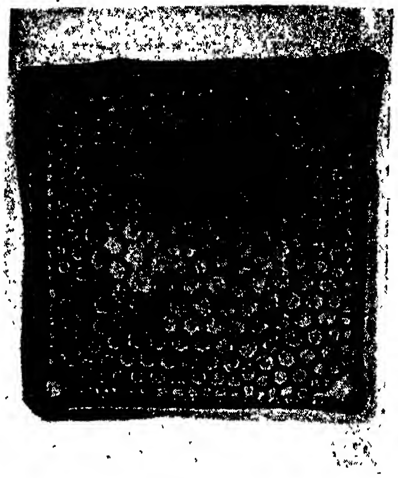
In the adult form of the higher animals the general shape of the whole is closely adapted to the life of the particular animal, but this shape is the result of the general growth of the animal which is taking



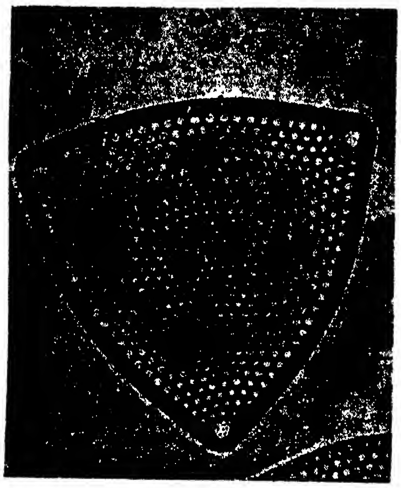
Triceratum



Aulacodiscus

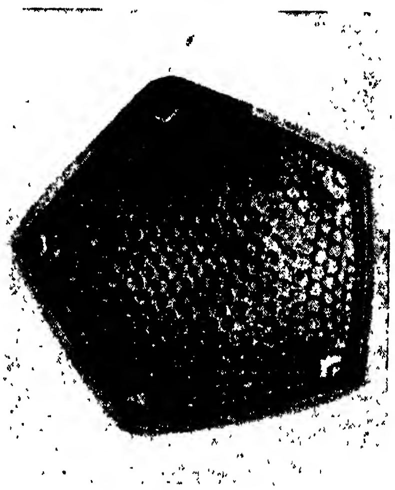


Triceratum

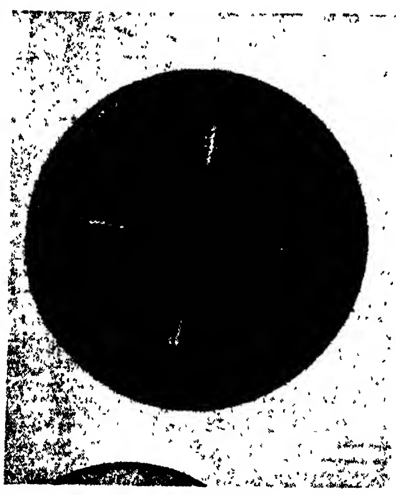


Triceratum

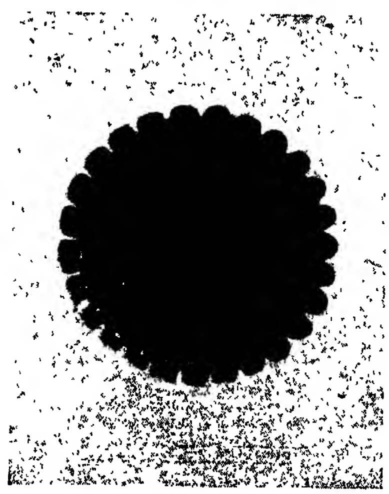
Navicula



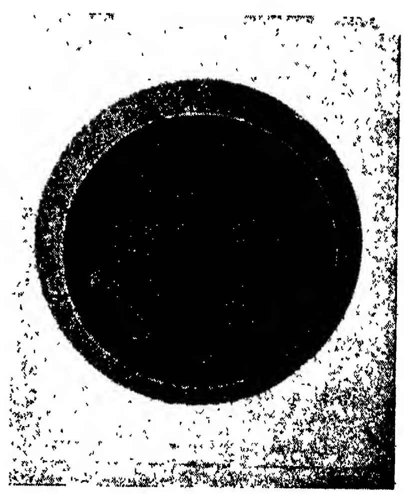
Triceratum



Aulacodiscus



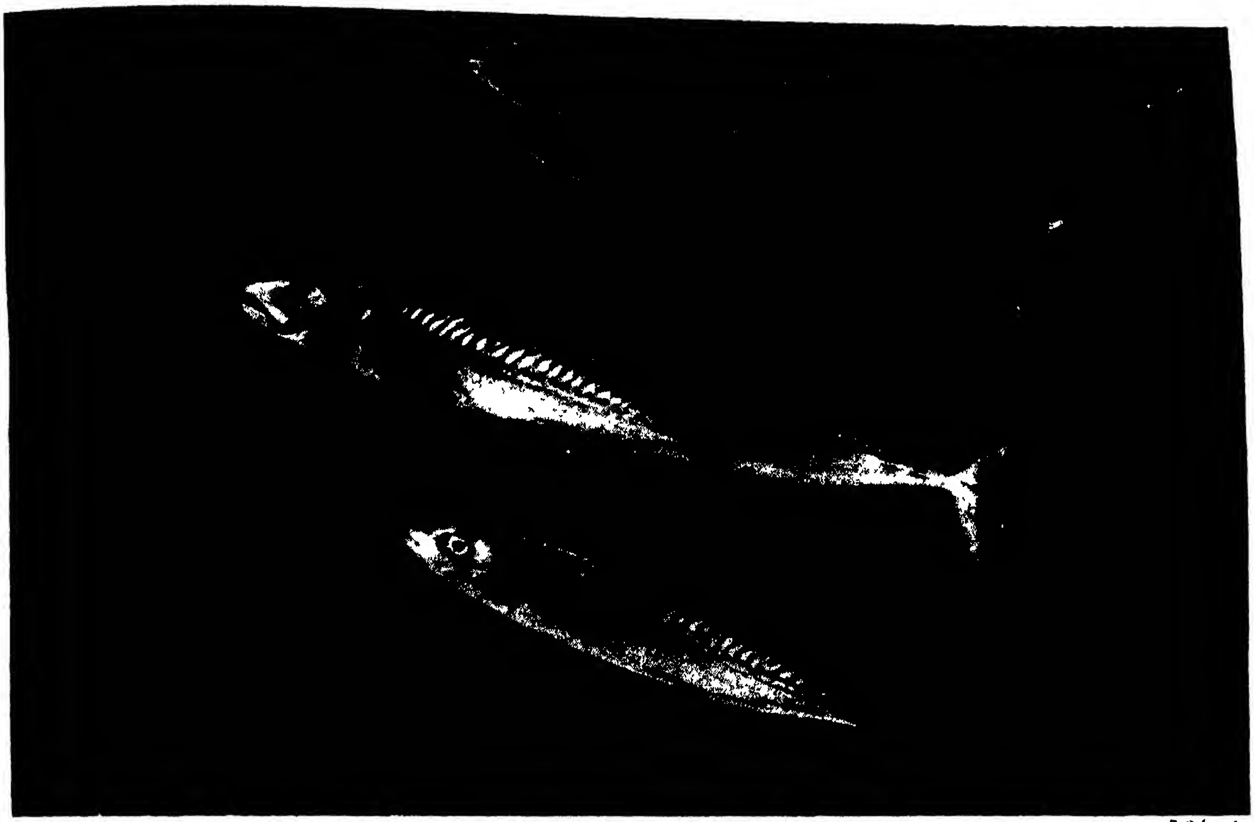
Echinus



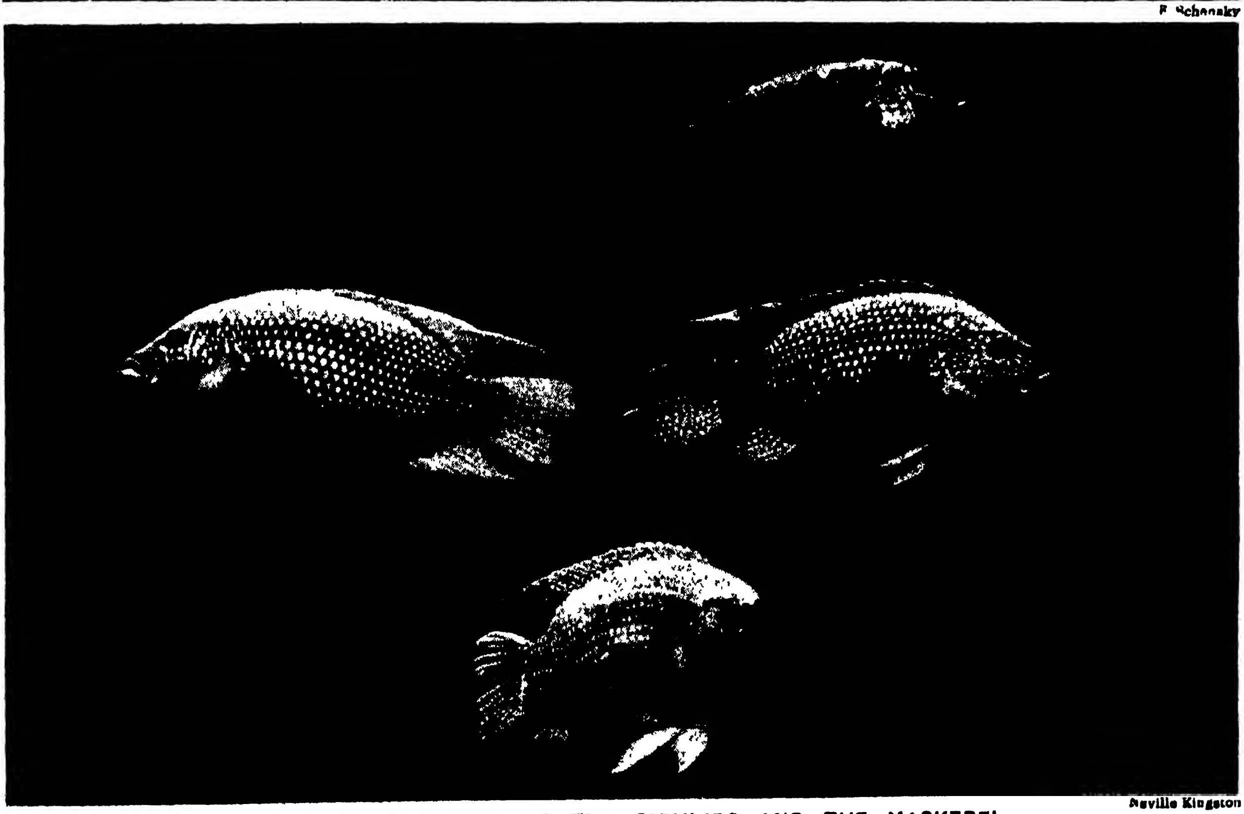
Aulacodiscus

LOWLY ANIMAL FORMS OF INTRICATE DESIGN

Triangular and circular shapes, patterns of the most extreme delicacy and as intricate as anything any Chinese craftsman ever spent a lifetime in producing, the skeletons of the radiolaria are one of Nature's greatest wonders. The skeleton of a mammoth is a simple piece of construction but the framework of these tiny creatures is so intricate that we can only observe and wonder. Above we have eight examples of these pieces of Nature's craftsmanship showing the amazing variety. The echinus is a sea-urchin. These photographs are by H. S. Cheavin.



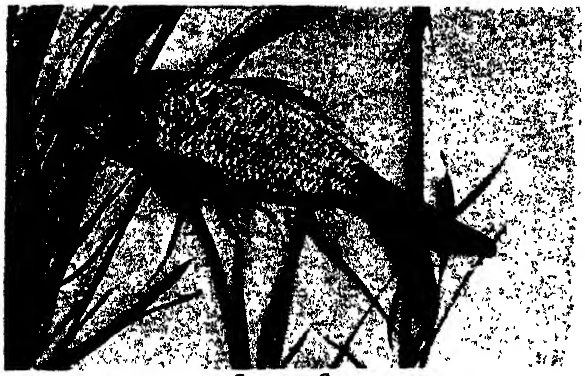
F Schensky



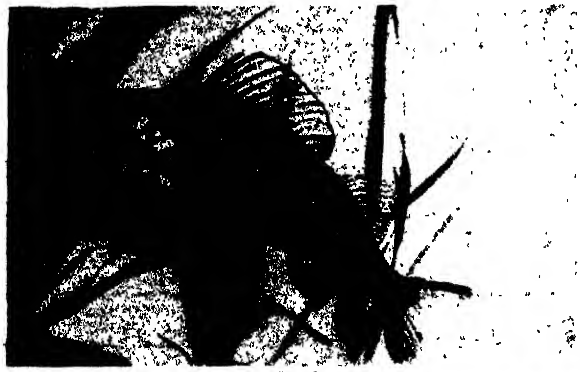
Neville Kingston

HANDSOME MARKINGS OF THE CICHLIDS AND THE MACKEREL

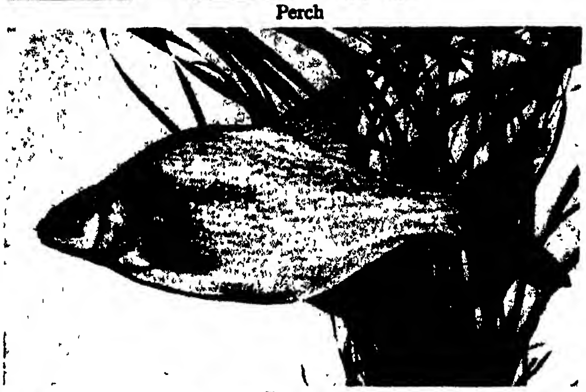
In certain of the African lakes such as Tanganyika and Nyassa, and in some rivers of tropical America, some representatives of the perch family are found called cichlids (bottom). Like so many of the perches they have handsome designs on their skins. The mackerel (top) is one of the most handsome of sea fish both in form and markings. The dark blue pattern along the top of the back contrasts at close quarters with green-blue, though, when seen moving in the water, these dark and light colours make a kind of camouflage.



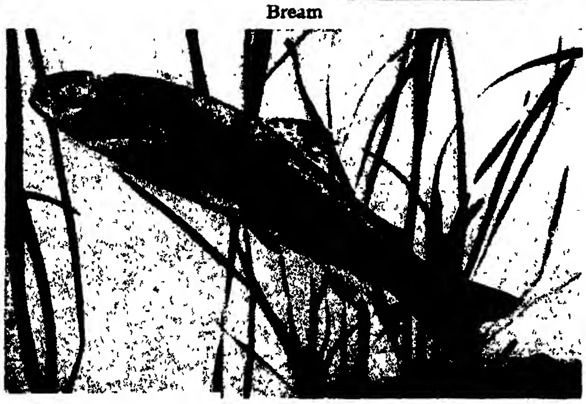
Common Carp



Perch



Bream



Rainbow Trout

VARIEGATED FISH SKINS

In the water the fish of river or lake wishes to be as inconspicuous as possible, whether it is playing the part of hunter or hunted. The markings then, though striking seen out of water, are all designed to blend with a background. Photographs by S C Johnson

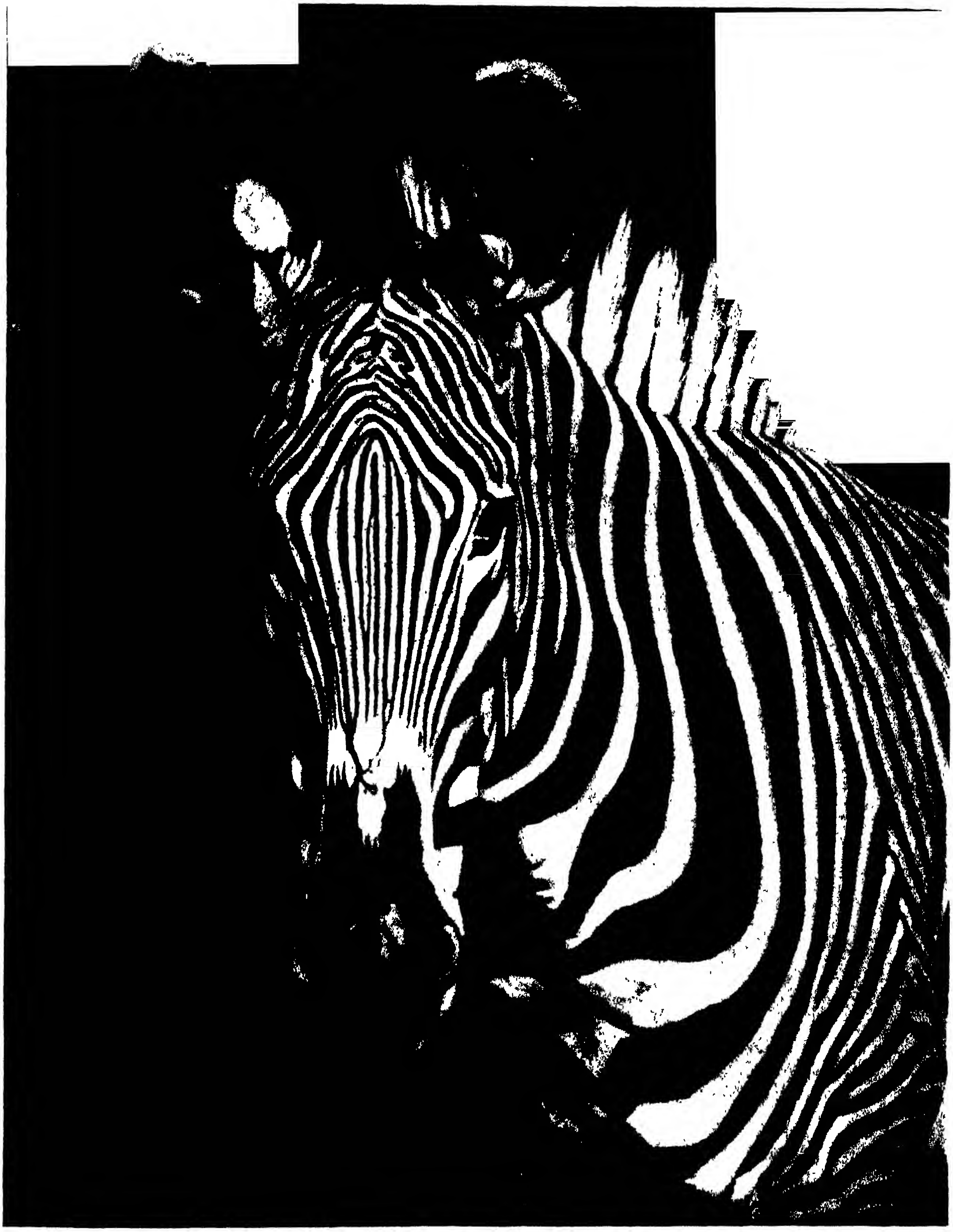
place in different ways and at different rates in various parts of the body and is often due to the differential growth of a considerable number of tissue masses at the different places. The whole animal becomes more independent of the simpler physical forces of its environment which, as we have seen, tend to result in geometrical forms.

A number of animals exhibit something of a regular star shape. This is perhaps best seen in the starfishes. This is an expression of what is called radial symmetry. It may be considered as correlated with a fixed or sessile habit of life. It is obviously an advantage for an animal fixed to one spot to be able to deal immediately with changes in the environment coming from any quarter of the compass by having such structures as food-catching arms or tentacles, sensory organs and so on placed all around the central body after the manner of spokes radiating from the hub of a wheel. Some of the near allies of the starfishes, the sea lilies, are actually fixed in one spot by a stalk and have this radial symmetry also, and this is found to be general among the whole group of echinodermata. In the free-moving forms the symmetry is probably an inherited form of body, the ancestral type of the group having been sessile. A similar radial symmetry is seen in the little fresh-water hydra and the marine sea anemones.

A BURROWING habit is also reflected in bodily form among animals belonging to various groups. The form of body best adapted to this kind of life is a cylindrical one with little in the way of projections. This we see in various worms, such as the common earthworm, and among the higher animals in the eel among the fishes, in some amphibia, such as typhlonectes, and in snakes among the reptiles.

Some of the most beautifully adapted shapes of body are to be seen in the fishes and birds. In both cases we find a body with an evenly curved outline. The general form is built on what the engineer would call stream-lines. He fashions the torpedo, the ship's hull, and the aeroplane hull in such a form. The curved sides of the body are such as to offer the least possible resistance to rapid movement through a liquid (water) or gas (air). The shape of a mackerel or the body of almost any bird shows this form to perfection. The fish is shaped like a sharp wedge in front, swells out very gradually and evenly along the sides, and becomes flattened again towards the hinder propulsive tail end. Looking a mackerel straight in the face is a revelation as regards form. Fishes which tend to lie on the bottom lose this form and become flattened as in the skate or plaice. On the other hand, some fishes float almost passively in the water, and have a more spherical shape, such as the globe fishes.

The eggs of various animals, especially those of birds and some insects, exhibit beautiful regular form and have excited curiosity and admiration from the earliest times. Amongst birds' eggs the majority are either nearly spherical, ellipsoidal, or else ovoid, with one end more pointed than the other. The differences between the eggs of different birds are



BEAUTEOUS DESIGN IN BLACK AND WHITE OF THE ZEBRA'S HIDE

Of Nature's patterns, as displayed by the animals, the zebra's is the most striking The hide seems as though the graceful markings—varying subtly with each individual—had been painted in delicately with a brush The beautiful pattern on the head, like so much stencil work, is particularly noteworthy in the example seen above. On the neck the stripes are continued up into the mane.

To face page 626

principally those of colour and markings. The shape of the egg appears to be due to various pressures on the egg in the stage before the shell substance has hardened. The oviduct down which the egg passes on its way to the exterior has muscular walls, and waves of contraction passing down this tube not only serve to force the egg along but also mould it into the shape it retains after the deposition of the hard shell. We may suppose that in those birds which lay a spherical egg, such as the penguin, the pressures on the egg are not great, the oviduct being large compared with the size of the egg. Thus the fluid portions of the egg, the white covered only by a membrane, take on the spherical form to be expected under these conditions, and the shell is formed on the surface of the membrane enclosing the white. In those cases in which the egg is large compared with the size of the oviduct the pressures on the egg are greater and the various ellipsoidal and ovoid forms result. The colour and markings on the egg shell are due to pigments, largely derived from the blood, being mixed with the shell-forming material.

The eggs of many insects, especially those of butterflies and moths, often exhibit extraordinary shapes and beautiful regular sculpturings on the surface. Here the differences between eggs of various insects are mainly those of shape and not of colour. These eggs are also moulded in an oviduct, and the final form is due not only to muscular pressure, but also to the shape of the part of the oviduct in which they lie whilst the outer shell is being formed. This shell is soft at first, and is stamped with the various regular sculpturings so often seen in these eggs. The hexagonal pattern on the surface, for instance, is apparently due to an imprint of the cells forming the lining of the lower part of the oviduct.

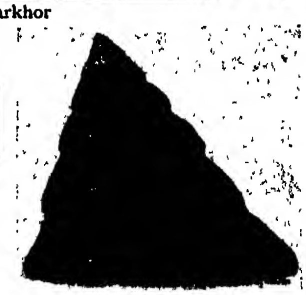
BEFORE concluding this chapter we must deal briefly with what is, perhaps, the most beautiful geometrical form to be found in nature, namely the spiral. Apart from a number of curves which are true spirals having certain mathematical properties, there is also one which is often confused with these—the simple screw or cylindrical helix. Such a curve as this does not begin from any definite point, nor does it vary its curvature as it proceeds. A true spiral does both of these. Among animals beautiful cases of the screw are to be seen in some protozoa, such as the spirochaetes and in parts of others. The stalk of the little vorticella, when contracted, assumes an extremely beautiful helical form.

There are many instances among animals of truly spiral formations. Many of the hoofed mammals have horns curved or twisted into beautiful spirals. Many varieties of sheep, goats and antelopes exhibit this well. The tusks of the mammoth and of the pig-like babirusa are other instances.

Among those animals whose whole body is spirally curved the most familiar cases are those illustrated by the shells of the mollusc and foraminifera. Here we have numerous cases of a remarkable curve called the logarithmic spiral. One of the properties of this

Markhor

Snail



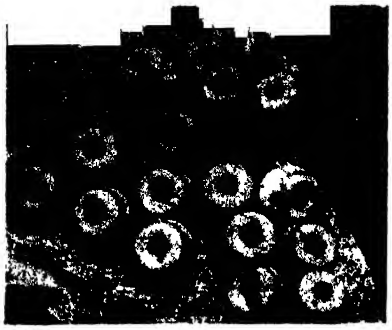
Trochus

Cingulata

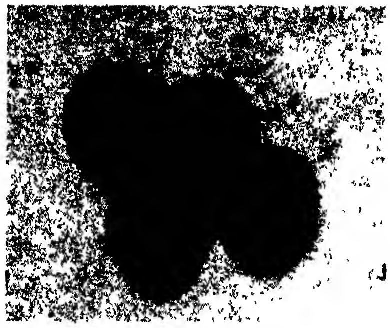
Butterfly's tongue

SPIRALS IN NATURE

Nature employs the spiral continually, and in many surprising ways. In things so diverse as the tongue of the butterfly, the snail's shell, and the handsome horns of the markhor, a wild goat of Afghanistan, we find this graceful design.



Vapourer moth



Grey knot moth

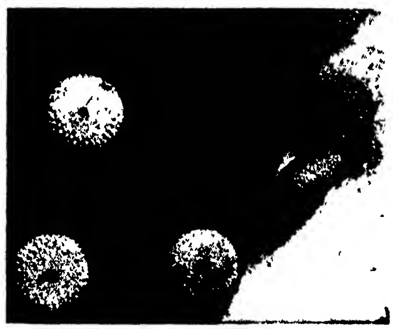
Quaker moth

Small white butterfly

September thorn moth

Comma butterfly

Dotted border winter moth



Silver studded blue butterfly

August thorn moth

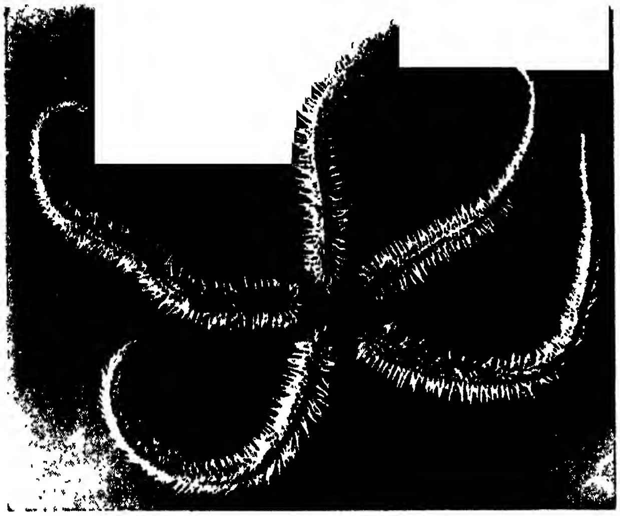
Small emerald moth

Magpie moth

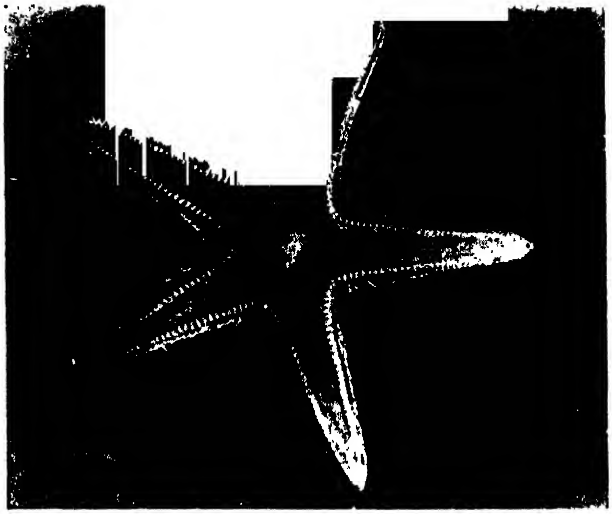
Scorched carpet moth

WONDERFUL FORMS TAKEN BY BUTTERFLY AND MOTH EGGS

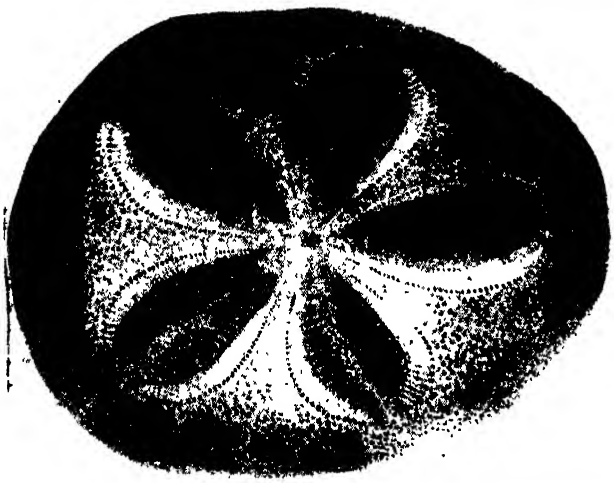
To the naked eye the eggs of butterflies and moths are so many minute particles seemingly no larger than the head of an ordinary pin. But the closer and more intimate inspection that the power of the microscope affords reveals some surprising facts. The eggs are, in many cases, not in the least egg-shaped ; and the variety of marking and colour shows an equally extensive range. The eggs of the grey knot moth are, for instance, white with red markings, and those of the Quaker moth like sea urchins. Photographs by M. H. Crawford and A. E. Tonge.



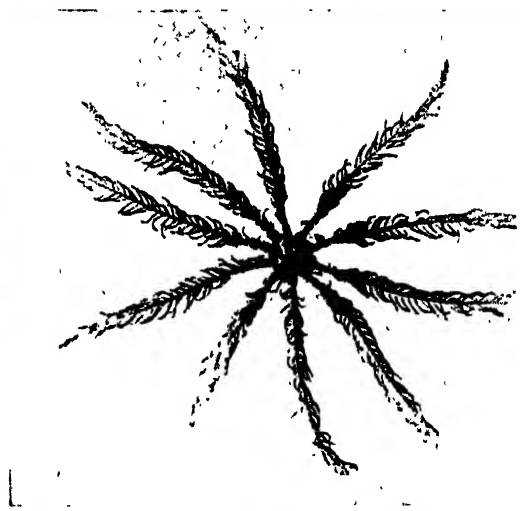
Brittle star



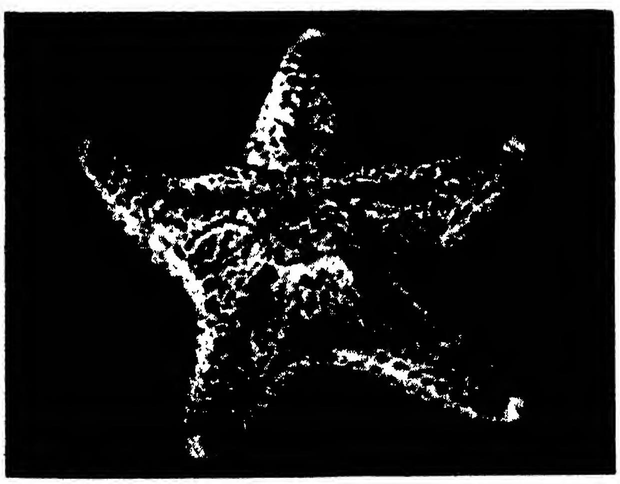
Butthorn starfish



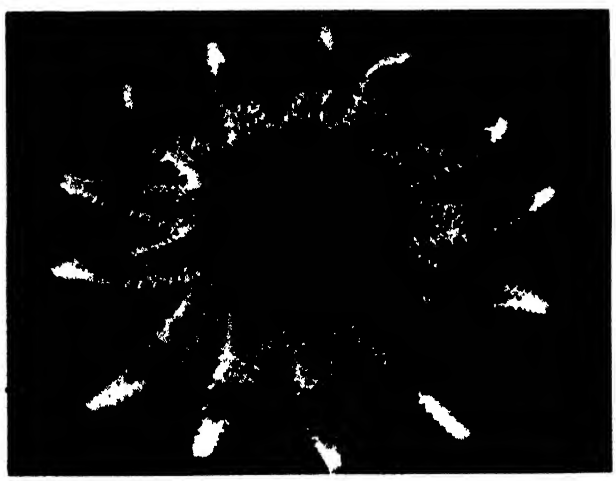
Sea urchin



Rosy-feather starfish



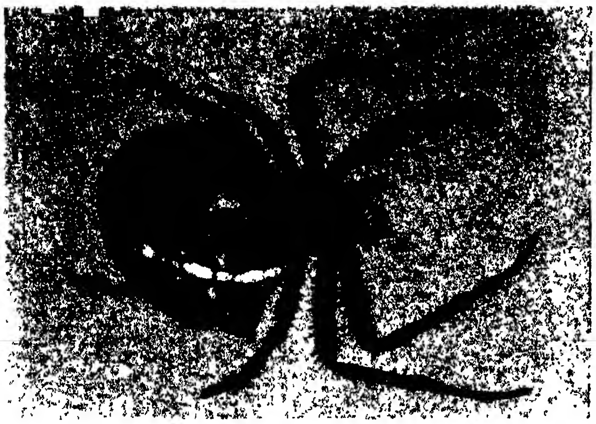
Cushion starfish



Sun starfish

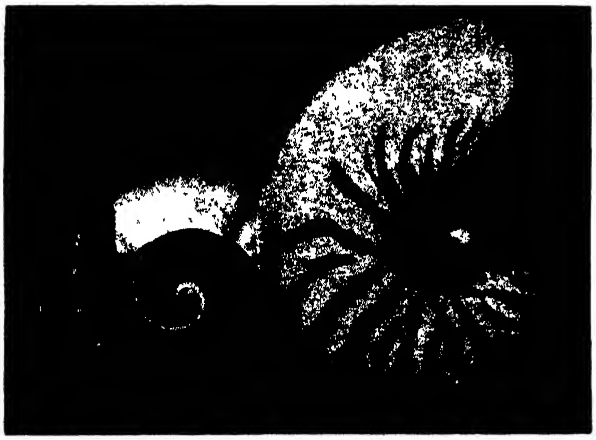
VARIATIONS OF THE STAR DESIGN IN CREATURES OF THE SEA

Just as a composer may take some simple musical theme and, having expressed it, then elaborate it, and yet that original theme is still the basis and inspiration of each variation, in the same way we find Nature starting with some simple design like the star and adapting it in all sorts of ways. In the starfish alone there is a number of different designs. Compare the cushion starfish with its thickened form and bright mottling with the sun variety or the rosy-feather starfish. Photographs by Martin Duncan.

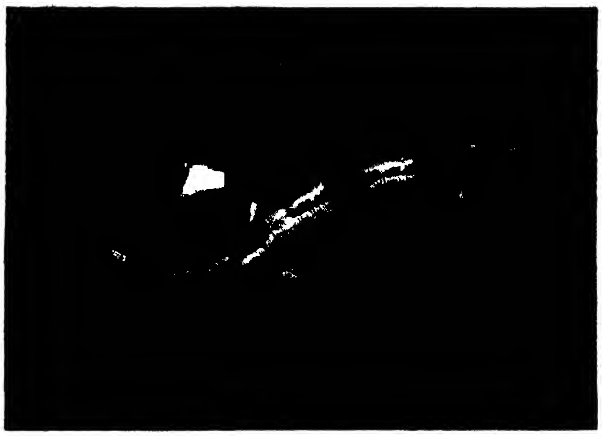


Cross-bearing spider

Death's-head moth



Pearly nautilus shell and section



Yellow-spotted salamander

Plume-like cirri of the adult barnacle

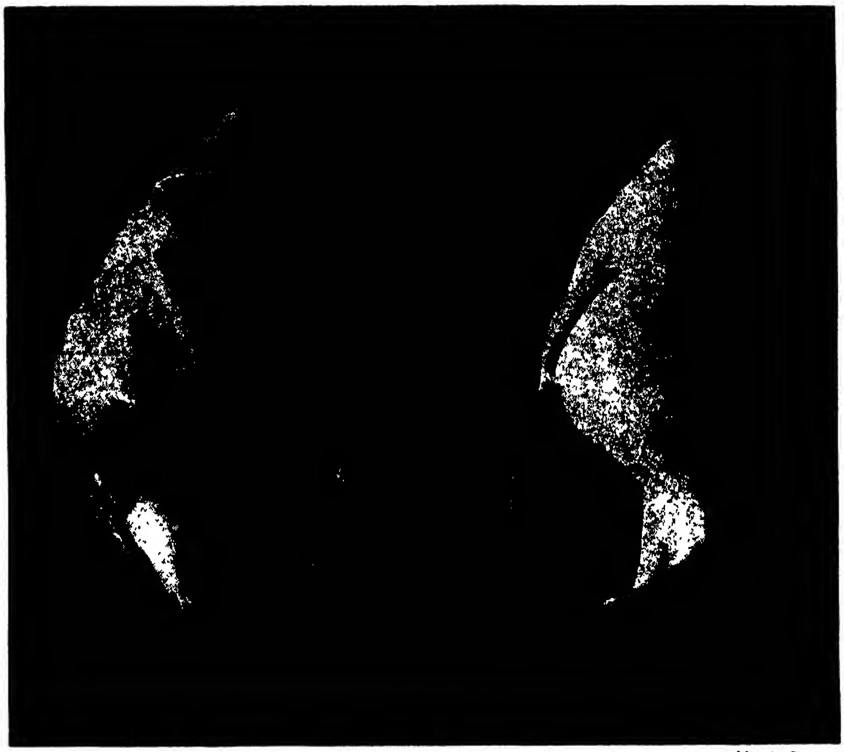
NATURE'S CRAFTSMANSHIP IN FORM AND COLOUR SCHEME

The pearly nautilus, valued by collectors of shells for its beautiful pearly whiteness when dead, is a dweller in the Indian Ocean. The shell when cut in half is seen to have a design reminiscent of the interior of a turbine. Each of these divisions marks a stage in the creature's growth, the nautilus occupying the outer chamber only. On the outside this shell is beautifully marked. The bottom photograph is of the cirri or tendrils by means of which the barnacle feeds. Photographs by Duncan, Bastin, Main, and Ward.

curve is that however much we lengthen it by extending its free end, the whole always retains the same shape.

A shell likewise, such as a snail shell, does not alter its shape as it grows larger. The whole at any period in the life of the animal is similar in shape to what was the whole at an earlier period. It is doubtless the property of continued similarity which is connected with the logarithmic spiral being so often associated with such structures as shells. The remarkable point to notice is that the shells retain the same form in spite of the fact that they grow at one end only, that is, at the open mouth of the shell. It is this property of retaining form whilst increasing by terminal growth which is characteristic of the logarithmic spiral.

Numerous examples of spiral shells might be given. Perhaps



Martin Duncan

J. J. Ward

GEOMETRICAL SHELLS OF SEA AND LAND

Below is a group of six cone shells from the Tropics, with their markings which are developed more or less on geometrical lines. Above are two snails. The rule with these snails is that the spiral shall go in a clockwise direction from the apex. Only one in a million is counter-clockwise, and a normal shell is given here together with one of the rare exceptions.

the simplest are those in which the spirals lie in one plane. The fresh-water shells planorbis and many foraminifera, such as discorbina, planorbulina, cornuspira, exhibit this. The most perfect form of this plane logarithmic spiral is, however, to be seen in the truly beautiful shell of the nautilus.

In most spiral molluscan shells the curve is drawn out along an imaginary axis and does not lie in one plane. These are called "turbinate" forms. All the snail-like shells exhibit this to varying extents. As examples, we have helix, turritella, trochus, haliotis, and many others. The various rib-like markings seen on many of these shells are witnesses of the method of growth. For instance, ribs running across the whorls of the spiral represent the successive positions of the mouth of the shell as the whole grows larger.

Sphere, ellipse, star and spiral, every form and design is some expression of Nature's laws working towards wonderful ends.

VULTURES USE A DEAD TREE AS AN OBSERVATORY

In French Guinea it is quite common, especially near the villages, to find a tree which has been selected by vultures as an observation poin where they may perch, waiting for something to turn up. A dead rather than a living tree is chosen, since the view from the former is no obstructed by leaves. These repulsive looking birds play a very useful part in the life of hot climates, since they remove the nuisance c putrescent bodies decomposing very rapidly in the sun. They observe the carcases from very great distances.

Chapter LIX

Animal Scavengers and Undertakers

By W. S. Berridge

Author of "Marvels of Natural History"

Although we are inclined to regard the occupation of a scavenger as a lowly calling, nevertheless it is one of considerable importance, for if decaying matter be left exposed for any length of time it is liable to prove a source of danger to humanity, spreading disease and pestilence.

In the cities, towns, and villages throughout the world mankind has to a greater or lesser degree organized a system for the removal of garbage, but elsewhere the work of scavenging is often entirely neglected, and is only carried out by those creatures that Nature has ordained shall exist either partially or wholly upon carrion.

It is perhaps difficult to realize in this country to what extent man is indebted to animals for the removal of offal. A visit to tropical climes, however, would clearly demonstrate their value, for in such regions not only does the care bestowed upon sanitary matters appear to diminish more and more as climatic conditions become hotter and hotter, but this lack of attention also coincides with the fact that under the influence of a scorching sun the carcases of dead animals and other decaying substances quickly reach the stage commonly designated in polite language as "high."

The most notorious scavengers of the animal world are the vultures, of which numerous species are found in both the New and the Old World. Soaring to great heights, and silhouetted against the blue sky, they wheel around in large circles on the look-out for some creature that has fallen by the wayside. Should one of them espy the carcase of a zebra, camel, sheep, horse or some other animal, it quickly glides down to the ground, its actions at once being observed by others who follow its example, until the body is soon surrounded by vultures that have suddenly appeared from all directions.

Rending the flesh to pieces with their sharp, hooked beaks, and quarrelling with one another in their eagerness to make the most of their opportunities, the birds will quickly finish their repast, leaving behind nothing but the bones. Often they will gorge themselves to such an extent that they are unable to fly, or even stand; but as long as anything remains to be consumed, they will continue to eat whilst lying on their sides, rather than acknowledge they have arrived at the stage of repletion.

But a vulture's life is not one continual feast, for sometimes the bird is forced to abstain from food for days on end, a fact that may well be considered as a blessing in disguise.

Although the various kinds of vultures differ from one another in size and colouring, most of them are characterised by having the head and the greater part of the neck almost, if not entirely, devoid of feathers. This peculiarity imparts a very repulsive appearance to the birds, but it is a wise provision of Nature that allows them to wallow in their food without their plumage becoming unduly soiled and clogged.

The largest of the vultures is the American condor, which may have a wing-spread of nine feet or more; while little inferior in size are the griffons, one species of which has been placed on the list of British birds because an individual was once captured in Ireland.

The eared vultures are curious on account of the fleshy lappets that depend from their rosy-red heads, and another brightly-hued species is the American king vulture, its head and nasal caruncle ranging in colour from vermilion to orange. The latter bird receives its name from the ascendancy it holds over other vultures, which are forced to stand on one side and wait while his feathered majesty feeds.

Some vultures have been given rather quaint names. The black vulture, for instance, is often called the "carrion crow"; the turkey vulture is spoken of as "John Crow"; and the Egyptian vulture is familiarly known as "Pharaoh's chicken." The last-mentioned, which is one of the smallest species, has the reputation of being the most foul-feeding bird that exists, no substance being of too disgusting a nature for it to consume. Its habits, however, render it of great utility to mankind, so much so, indeed, that the bird is protected by special laws.

The marabou stork is another bird that receives the benefit of protection. Taking advantage of its freedom from molestation, it roams about the towns and villages in India, picking up and swallowing all kinds of offal, and even devouring such unappetising items as dead cats. Ungainly looking, bald-headed, and possessing an enormous beak and a large, pendulous pouch upon the lower part of the neck, the bird yields the soft "marabou" feathers that were formerly employed to a great extent in the manufacture of ladies' boas or neck-wraps.

South America is the home of some birds called caracaras or carrion hawks. Although offal eaters, they will also slay living animals. They will sometimes hunt their prey in packs, like wild dogs, and Mr. W. H. Hudson tells us that "they are the unfailing attendants of all flesh-hunters, human or feline, and also furiously pursue and persecute all eagles and true vultures that venture on the pampas."

One species, found in the Falkland Islands, and known as the chimango, is of such a bold disposition that it habitually resorts to the neighbourhood of human habitations on the look-out for any offal that may be cast on one side. Several of the birds will often co-operate and overpower living prey, and it is recorded that they will stand at the entrance of a rabbit burrow, ready to pounce on the inmates

Familiar avian scavengers to be met with in Britain and elsewhere are the seagulls, countless numbers of which frequent the coasts and add a picturesque touch to the landscape. They congregate in harbours, searching the mud-flats for anything of an edible nature that may be left behind by the receding tide, and picking up in their beaks, whilst in full flight, any tit-bits floating upon the surface of the water. On the arrival of the fishing-smacks at the ports the gulls will gather and hover around until the catch is unloaded and

With the kea parrot of New Zealand we come to a bird with a very strange history. Although normally feeding upon fruit, seeds, berries, nuts, roots and grubs, in those localities where the carcases of sheep are dealt with for exportation it has acquired a liking for offal. But not being content with dead mutton, it has also turned its attention to living sheep, settling upon their woolly backs, boring through their flesh with its sharp beak, and feeding upon the kidney-fat of its victims, so that they die as a result of the wounds thus inflicted. Parties of keas have been known to cause the death of a number of sheep during the course of a night, and sheep farms have been abandoned owing to their depredations.

Although the birds have been given a very bad character, it is only just to state that many people consider they are not such villains as they are reputed to be. Some individuals are certainly guilty of the crime attributed to them, and the New Zealand Government pays a reward for every one killed but the amount of injury suffered by the flock-masters has probably been greatly exaggerated, and of the millions of sheep on the New Zealand pastures but an infinitesimal proportion succumb through the kea's unwelcome attentions.

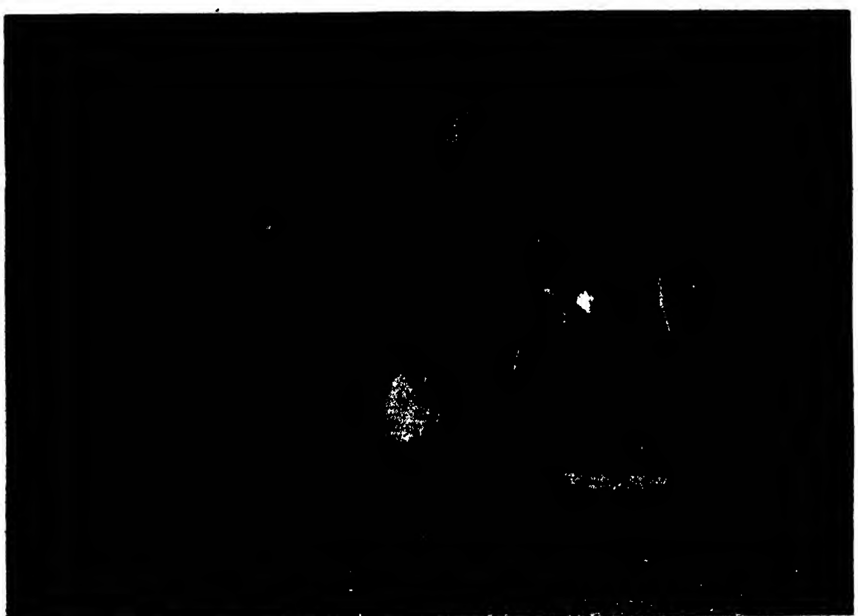
E.N.A

VULTURES SEEKING THEIR LOATHLY FOOD

The lower photograph shows a group of palms outside the town of Vera Cruz, Mexico. The great fronds are well suited for the purpose of the vultures we see settled on them, for the birds get a clear view. Above are some more Mexican vultures grovelling for filth in the bed of a creek used to carry off the sewage from a country town.

cleaned ready for dispatching to the inland markets, pouncing upon and swallowing any offal that may be cast on one side. At one Cornish seaport it is the custom to dispose of the refuse from the fish-market by putting it in a small boat and throwing it into the sea about half a mile or more from the shore. The gulls assemble every day at the harbour mouth, and when the man in charge of the boat commences to shovel the offal overboard into the water, they surge around the feast in such numbers that the craft and its occupant is almost lost to view amidst a swirl of snow-white wings. But after an interval of about five minutes not a particle of edible matter remains uneaten, and the shrieking birds one by one make their way to some rocky prominence where they may rest and digest their repast at leisure.

We may well bestow our blessing upon the seagulls, for of all refuse that from a fish-market is probably the most vile and offensive to the human olfactory organs.



W. S. Berridge

DESTROYERS OF REFUSE: EGYPTIAN AND TURKEY VULTURES

Known familiarly as "Pharaoh's chicken," the Egyptian vulture (top) is said to be the filthiest feeder on the world's surface, for nothing is too vile for its taste. The bird is therefore very useful in a hot climate where sanitation and hygiene are not everywhere of a high standard The lower photograph shows a turkey vulture, in the London Zoo, with a fine wing span

Many dwellers within the sea and rivers are scavengers, the eels, the hag-fish, the cod, lobsters, crayfish, prawns, shrimps and crabs all feeding to a greater or lesser extent upon dead animal matter.

The common hag-fish, an elongated and slender creature measuring about a foot in length, feeds mainly upon dead fish or those that have been hooked on the lines laid by the fishermen. It burrows into the bodies of its victims through their eyes or gill-covers, feeding upon their flesh until only skin and bone remain. Instances have been recorded of sharks being thus devoured by the voracious hag-fish, but as a rule it is the members of the cod tribe that are the chief sufferers from these attacks.

The cod itself is a most omnivorous feeder, and assists

E.N.A.

VULTURES GORGED AND RESTING AFTER A MEAL

There is always competition for the vultures, for they not only scan the country for dead or dying creatures, but keep an eye on each other. If one bird swoops down there is another within sight who will notice the movement and make for the same quarry. Then the food is bolted until the bird can hardly stand (bottom). It then digests on some perch (top).

in the work of ridding the sea of refuse. Although normally subsisting upon such fare as small fish, crustaceans, worms, etc., it will swallow almost anything of an edible nature, and not infrequently that which is otherwise. Mr. J. R. Norman tells us that keys, pieces of tallow candle, a partridge, and a black guillemot are to be numbered among the strange items of diet found in the stomachs of cods; while one even went so far as to swallow a small book.

Both the common eel and the conger eel are great scavengers, the latter being also addicted to cannibalism and feeding upon its smaller brethren should a favourable opportunity arise.

Crabs are indefatigable in their quest for all sorts of offal, consuming quantities of decaying matter that would soon foul the water if left to accumulate.

The starfish is yet another scavenger of the sea, for, besides preying upon living oysters, it will feed upon dead bivalves and other animal refuse; while among the fresh-water creatures that do not disdain to consume offal is the crayfish, a crustacean resembling a lobster in appearance, though much smaller.

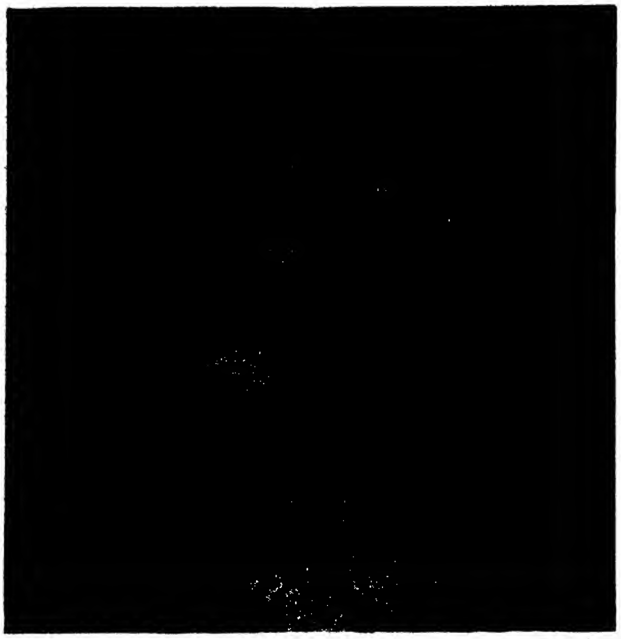
But to return once again to terrestrial creatures, let us consider those mammals that follow the occupation of a scavenger.

Among these are to be numbered the hairy armadillo or peludo, a creature that is omnivorous in diet, such items as ground-nesting birds, insects, worms, vegetable substances, and putrid flesh all being regarded as acceptable fare. It will burrow beneath the

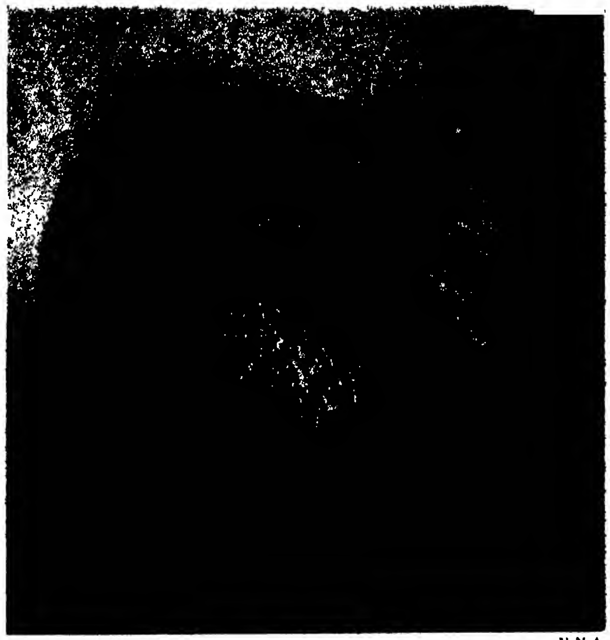
W. S. Berridge

MARABOU AND ADJUTANT STORKS, SCAVENGERS OF INDIA

Both the marabou (bottom and top right) and the adjutant storks (top left), which belong to the same family, are thought much of by the natives of the lands where they dwell—India and Africa. This is on account of their usefulness as removers of refuse, the marabou being quite equal to a dead cat or dog. These birds are free from persecution and wander through the villages undisturbed. The adjutant seems to have got its name because its impressive pacing has a resemblance to the movements of one of the more dignified military officials



W. S. Berridge



E N.A.

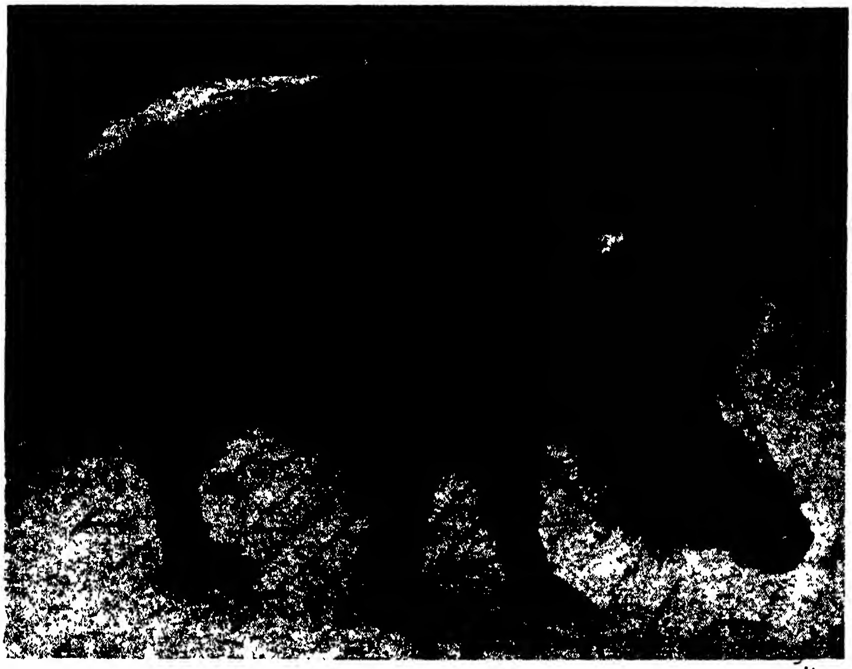
SEA GULLS, VULTURE AND CALIFORNIAN CONDOR

While gulls hunt their food to some extent they are also confirmed scavengers, as anyone will know who has watched the screaming confusion round any large dead fish which is floating on the surface and has been noticed by the gulls. Our lower photograph, taken by the harbour at Plymouth, shows two birds fighting for the possession of a dead fish. Above are a Pondicherry eared vulture (top left) and a Californian condor (top right). The condor is the largest of the vultures and may have a wing span of nine feet.

W. S. Berridge

EATERS OF OFFAL AND CARRION FROM NEW ZEALAND AND AMERICA

In New Zealand, where there are factories which deal with the carcases of sheep slaughtered for the chilled meat trade, the kea (bottom left) a kind of parrot, has forsaken its normal parrot's diet of fruit and seeds and taken to eating offal. From this it has gone on to pecking the fat round the kidneys of living sheep. The other birds seen here are from America. There are a Brazilian carrion hawk (bottom right), a Mexican buzzard (top left), so tame owing to universal protection that it lets the photographer approach to within close range; and an American king vulture.



James

carcass of a dead sheep, horse or cow, as the case may be, returning night after night to feed upon the flesh.

The peba armadillo also feeds largely upon carrion. Often it will carry some of the flesh to its burrow, where it is stored in readiness for future consumption, the repast doubtless improving in flavour by being kept in this manner.

MANY members of the dog family will eat refuse. Wolves, for instance, will consume almost anything of an edible nature when hungry; in Eastern countries jackals prowl about the outskirts of the towns and villages, picking up any offal they may discover; while the common fox is another creature that will feed upon similar fare.

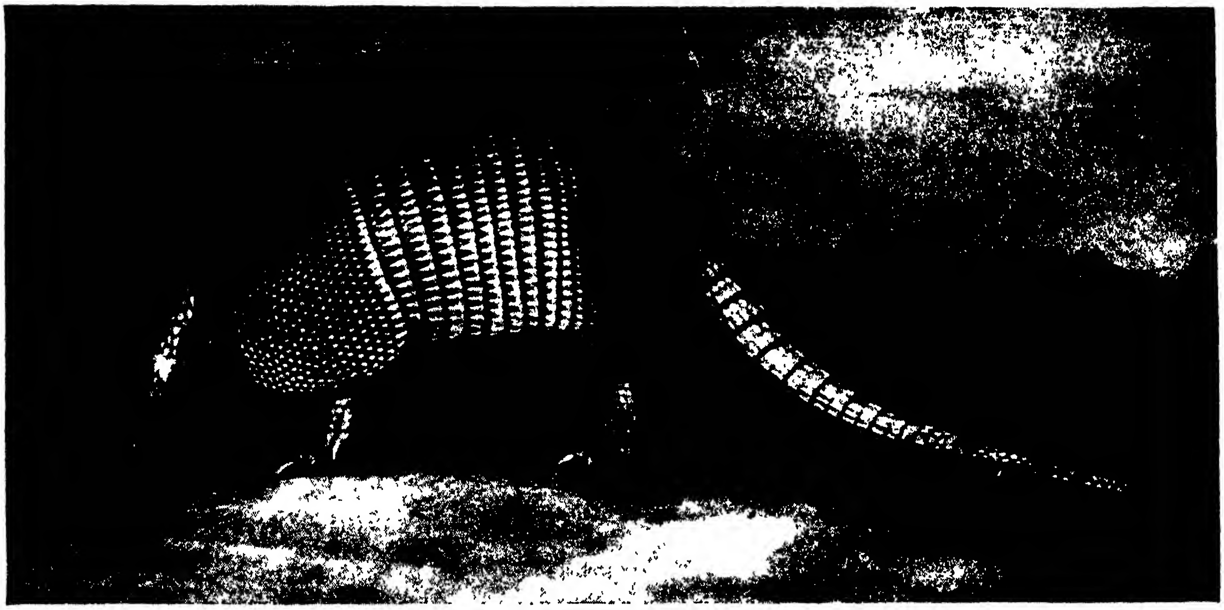
But the most notorious of mammalian scavengers are the hyenas. They will visit the Eastern villages at night and feed upon carrion; while skeletons that have been picked clean by other creatures are not disdained by these ungainly-looking beasts. With one crunch of their powerful jaws they will break in half the thigh-bone of an ox, so as to obtain the marrow, and their digestive powers are so great that they can swallow whole a knuckle-bone without fear of suffering any ill results.

Many fabulous stories have been related in regard to the hyenas, not the least remarkable being that they changed their sex every year. Should their shadow fall upon domestic dogs, the latter would become dumb; while they have even been credited with the power of imitating the voices of men, and even of calling them by their names.

Bears must also be included under our heading, for some of them will consume offal. The body of a dead whale is much appreciated by the polar bear, and it does not object to feast

RED RIVER-HOG AND WILD SWINE OF ARABIA

Swine, both wild and domestic, are notorious for their foul feeding, although when domesticated this depends on those who look after them. One of the most interesting of the wild pigs is the red river-hog (bottom) which stands only about two feet high at the shoulder and is a bright red-brown. This is set off by patches of white on the cheeks, while the eyes have white markings round them. The legs are black. Above is a wild swine from Arabia.



W. S. Berridge

ARMADILLOS WITH A LIKING FOR HIGH MEAT

The peludo, or hairy armadillo (bottom) has a novel way of dealing with the carcase of any sheep or horse which it may find. It burrows right underneath its intended meal and will return night after night till there is nothing left. The peba armadillo (top) is also a carrion eater but prefers to take its food home and keep it for a time.

upon the flesh when in a putrid condition. The American brown bear will eat decaying fish, as well as the carcases of dead animals; while the black bear often becomes quite tame and visits the neighbourhood of the hotels in the "up country" holiday resorts, searching among the garbage-heaps for any toothsome morsels that take its fancy.

Both wild and domestic swine are scavengers, and in tropical countries they are especially beneficial to mankind. Domestic pigs, however, are not normally such foul-feeding and dirty creatures as they are reputed to be. When kept in sties they can but subsist upon such fare as is provided for them, and the state of their cleanliness is entirely governed by the conditions under which they are kept. In the Highlands, domestic pigs are often allowed to roam over the moors, and in coastal districts they will visit the sea-shore to feed upon dead fish and molluscs, their flesh thereby acquiring a fishy flavour.

The house rat, or Old English black rat, and the common or brown rat, are feeders upon all kinds of offal, but the value of the service they thereby render is greatly discounted owing to their being bearers of the plague, or "Black Death," as it was formerly called. At intervals this terrible scourge becomes epidemic amongst these rodents, and the fleas that infest their persons leave the dying creatures and search for new hosts. Should the parasites be unable to find another rat upon which to bestow their unwelcome attentions, they may settle upon man, and by their bite infect his blood with the terrible plague bacillus.

As implied by its name, the house rat often takes up its residence in human habitations, but the common rat frequents sewers, drains and waterways, although not infrequently residing in the cellars and basements of buildings. Owing to its greater size and hardier constitution the common rat has almost exterminated the house rat, but from time to time new colonies of the latter become established, the rodents arriving as stowaways on ships.

Among the lower forms of animal life, there are a number of beetles and flies that are accustomed to feed upon decaying matter.

Familiar examples of the former are the carrion, burying, or sexton beetles, seven kinds of which are by no means uncommon in the British Isles. Most

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HYENA AND THE PARIAH DOGS OF OXIA ISLAND

Even skeletons already picked bare by other animals are welcome to the hyena (bottom), which can snap the thigh-bone of an ox for the marrow inside. The island of Oxia (top), in the sea of Marmora, is the home of the descendants of the pariah dogs of Constantinople which were cleared out of the city and marooned here in 1910.

into the cavity that has been excavated, and is covered up by the earth falling from above. Carcases are sometimes buried in this manner a foot deep.

When the interment has been completed, the female beetles lay their eggs within the decaying flesh of the animal they have buried. These soon hatch, and the grubs that emerge at once commence to feed upon the food supply amidst which they were born, gradually consuming it until none is left. The grubs eventually burrow into the soil, where they fashion small cells and change into the pupa stage. Fifteen days afterwards they emerge from the chrysalis as fully developed insects, which fly away and continue the sequence of life.

The scarab beetles are other well-known scavengers. They feed upon the dung of horses and sheep, rolling up the substance into a ball about the size of a walnut and trundling it along with the aid of their feet to their underground home, where it is consumed at leisure. But special pellets are also made wherein the females lay their eggs; the grubs, when hatched, feeding upon the material thus provided by their mother.

Of the many different kinds of scarab beetles, the Egyptian species is of special interest. Not only was it regarded as sacred by the ancient Egyptians, but its likeness was often represented upon their tombs,

of them are black in colour, decorated with broad, orange bands. Endowed with a very acute sense of smell, these insects will soon discover the presence of a dead mouse, mole, or small bird. Flying one by one to the carcase, they quickly settle down to their work, and commence to remove the soil from around the defunct creature. They then make their way beneath, and after an interval of a few hours undermine the body, which sinks by its own weight

as well as upon their rings and amulets. The curious, notched protuberances upon the front of the beetles' heads, as well as the tooth-like projections on the outer part of their fore-feet, were considered to be symbolical of the rays of the sun, and the spherical pellets the insects made as symbols of the earth; while the creatures' association with the moon rested upon the belief that the beetles did not commence to feed upon their hidden treasure until 28 days (a lunar month) after being buried.

The common mealworm, as well as the beetle into which it transforms, will feed upon dead and decaying matter, but although it thus carries out very useful scavenging work, should it become established in flour and grain stores, it proves a perfect pest.

W. S. Berridge

CARRION BEETLES OF EGYPT AND EUROPE

Scarab beetles lay their eggs and feed upon the dung of sheep, rolling the substance into pellets (bottom). The sexton beetles (top) undermine any small corpse they find until it falls into the cavity. They then feed on, and lay their eggs in, it.

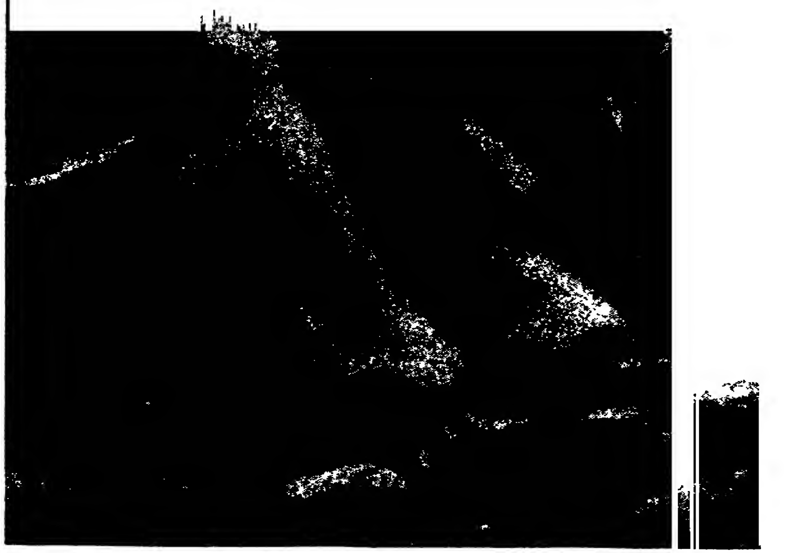
In a similar manner house flies are both benefactors and a menace to mankind. Feeding upon all manner of refuse, they settle upon food intended for human consumption, leaving behind bacilli they have collected and carried upon the pads of their feet and other parts of their bodies. In regard to the common house fly, the late Professor Lefroy, the great authority on insect pests, states that "its hairy, sticky feet, and the habit of regurgitating the contents of its crop and depositing its excreta at frequent intervals, constitute it an excellent inoculating agent for any bacteria it may pick up in the satisfaction of its unsavoury tastes."

Cholera, consumption, anthrax, typhoid and enteric fever may all be spread by flies, and in military camps they are the chief disseminators of the two latter diseases, many severe epidemics among troops having been definitely traced in the past to them Still, although flies are such a source of danger as distributers of disease, in their larval form they accomplish an immense amount of good work. The maggots of the common house fly and the lesser house fly feed upon decaying vegetable substances; while those of the blow-fly, the blue-bottle and the green-bottle subsist upon fresh and putrid meat, as well as upon the carcases of dead animals. So great are the numbers of eggs laid by a female fly, and so voracious are the appetites of the maggots, that enormous quantities of food are consumed in a very short time. For this reason the grubs are to be numbered among the most efficient of animal scavengers, and the benefit they render in that stage counteracts to a great extent the harm they do as flies.

THE larvae of some of the hover-flies will feed upon decaying animal and vegetable matter, as also will the small, worm-like grubs of fleas; while to conclude our survey of "Animal Scavengers and Undertakers" mention must be made of the ants which will rapidly devour the body of a dead mouse, bird, or some other small creature, leaving behind nothing but a cleanly-picked skeleton.

The large, black ants, known as driver ants, and found in the African jungle, not only feed upon dead creatures but also on the living. When on the march they form up in files that have been known to extend for nearly a mile, and woe betide any animal that dares to dispute their path. A swarm of these tiny insects has even been seen attacking a venomous horned-viper.

For more than a quarter of an hour the reptile writhed about upon the ground with its body covered with ants tearing away at its flesh with their powerful jaws. Gradually the struggles of the snake grew weaker and weaker, until at last it lay lifeless upon the ground. The carcase was soon completely hidden by a mass of ants, two inches in depth, all intent upon obtaining a meal, and in a very short time only the victim's bones remained



LUMP-SUCKER OF THE NORTH SEA THAT MAKES A VERY PRIMITIVE FORM OF NEST

As soon as the female lump-sucker has deposited her eggs the male proceeds to make a depression in the slimy, weedy surface of the rocks and presses the mass of eggs into it. The eggs are held together by a slimy substance which hardens in the water and enables them to adhere to the rocks. The process of making this very primitive nest takes the fish from five to fifteen minutes, and during this time the eggs are fertilised. After this the male fish loses the bright red tints on its skin. Lump-suckers are found along all the coasts of the North Sea and Baltic, although nowhere in great numbers. Their name arises from the fact that the ventral fins are united into a round disk, which exerts suction and enables the fish to cling to rocks and seaweeds.

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Chapter LX

Nests Under Water

By Wilfred Mark Webb

Secretary, The Selborne Society

THOSE useful sportsmen whose choice falls upon a camera instead of a gun have of recent years made widely known the domestic life of British birds. Mention, therefore, of the word nest conjures up in the minds of many people one of those delightful nurseries upon which even common kinds like the chaffinch and the long-tailed tit lavish a wealth of skill and labour.

These have their rivals, however, among four-footed animals, for the squirrel builds its drey in a convenient tree and the tiny harvest mouse supports its nest upon the stalks of ripening corn. In both of these homes the young are housed, but the dormouse also builds one for itself in which to sleep away the unfruitful months of winter.

At times no elaborate work is done and a nest may be merely a specially chosen place. Such is the hollow in the ground in which the night-jar lays her pair of eggs or the ledge of rock on which the guillemot sits upon her single one.

Nature too in some cases saves her creatures from being tied, even temporarily, to one spot while their children are helpless, by giving them a natural pocket, or pouch as we call it, so that they can carry their little ones about wherever they go.

Nests underground are not so familiar to the sight as they are by name. The rabbit makes a special burrow for its progeny and lines the end with wool from its breast, but insects with highly developed social instincts such as certain wasps and humble bees, construct a series of single-berth nurseries in a common dwelling inhabited by the queen-mother, the nurses and their charges. The less highly developed earwig is worthy of note, for the mother does not go away and leave her eggs as do most solitary insects, but watches over them until after they are hatched.

More out of the way still are nests under water and for that reason it may be interesting to consider what they are. True, we shall find no birds or bees, but examples will not be lacking of craftsmanship and parental care among other creatures which are lowlier in structure or in intelligence, such as frogs and fishes, spiders and various insects.

Practically speaking all the eggs which are laid under water have to develop in that liquid and are those of forms which live in water and breathe by means of gills during the early part of their actual existence, if not the whole of it, but we shall find one exception, at least, in Great Britain of another kind of animal of which the eggs are hatched below the surface of a pond or stream.

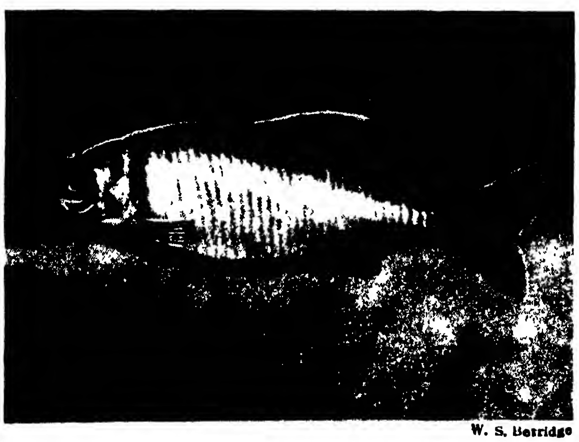
Except in rare cases among the nest-builders which live on land, when the work of looking after the eggs and young falls to the lot of one parent, it is the mother. We shall see, however, when we come to the water that among amphibia and fishes, at least, when a nurse is provided, it is the father who usually takes on these important duties. The British frogs and toads, which belong to the first-mentioned class and have a free-swimming tadpole stage, do not seem to trouble much where they lay their eggs when once they have got back to the water, and therefore in common with most creatures which do not look after their young they have an offspring so numerous that the chances are that some, at least, will survive.

Frog's spawn floats in masses on the surface but that of the common toad may be likened to transparent necklaces in which many small black beads have been embedded at intervals, and these remain under water attached to submerged plants.

The eggs of a Continental form known as the midwife toad are laid on land and being larger and less numerous have been likened to rosaries. The male in this case is very solicitous for his children's welfare. He wraps the chains round his hind legs and from time to time moistens them with dew at night or dips them into water. Ultimately when they are ready to hatch he takes them into the water. The male of the curious Surinam toad, which spends its whole life in water, also looks after the eggs as they are being laid. He does not, however, carry them about himself but presses them on to the back of the mother where each sinks into a little pouch which forms beneath it, and there development takes place.

The hiding-places which some toads prepare for their eggs are not at first under water, being made during the dry season, but spots are chosen which, when the water rises after the rains, will be certain to be submerged.

In the case of a Brazilian tree frog called the



W. S. Berridge

BITTERLING THAT USES A LIVING NEST

A strange form of nest is used by the female bitterling, a small fresh-water fish of the carp family. The eggs are laid by means of a long ovipositor inside the shell of a fresh-water mussel, which thus involuntarily acts as a foster-mother and nest in one.

W. S. Berridge

and green he sets to work to gather bits of waterweed and other vegetable filaments and builds quite a fine nest. He does not trust entirely to his skill in weaving to keep the component parts in place but sticks them together with a glutinous secretion. It might be thought that this comes directly from the fish's mouth, with which he seizes and carries his material, but it has been shown to be a special secretion from the creature's kidneys.

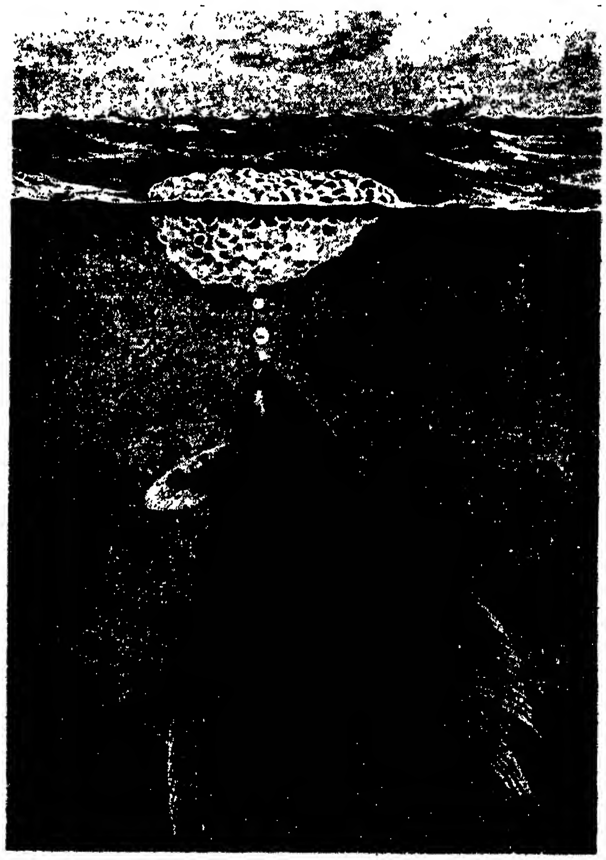
The species under consideration builds its nest on the bottom, and when it has been put together, if its maker is not satisfied with the appearance, he tidies it up by pulling out any piece which makes it appear ragged, and tucks it in

" smith "—because the noise which it makes sounds like the beating of metal—the female is a wonderful nest maker. Unaided by the male or even hindered by his attentions, she builds up from the bottom of the pond at a place where it is not too deep, a circular wall of mud so as to enclose a little private pool in which her eggs can hatch and the tadpoles develop. Very remarkable is the way in which she smooths the inside of the walls with her hands and the parapet which rises above the water. The bottom of the pool is also carefully levelled.

Both the male and female of another tree frog found in Paraguay combine to secure the safety of their eggs, which are deposited in a funnel which they together make of a leaf at the water's edge. The jelly with which the eggs are, as usual, surrounded serves to stick the edges of the leaf together and prevent it from unrolling when the frogs release their hold, so that the eggs remain hidden.

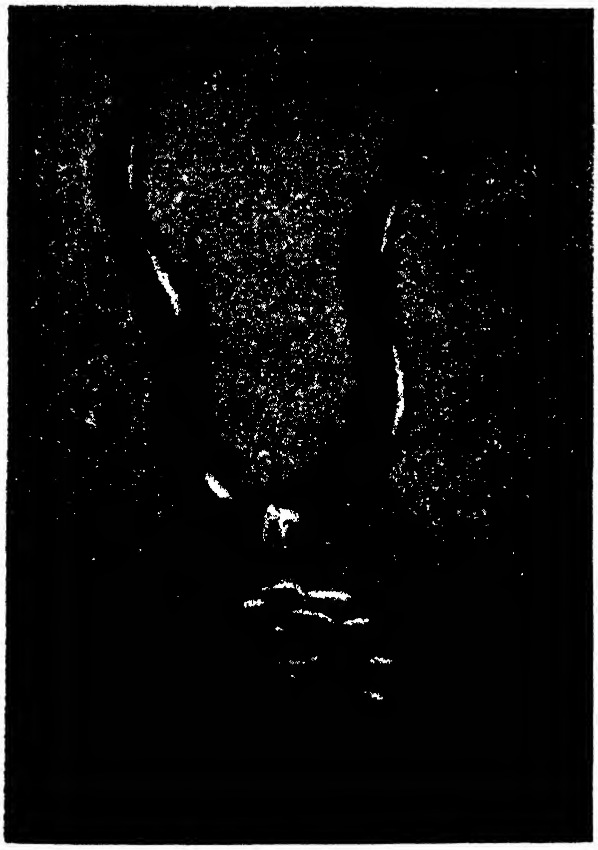
When we come to fishes, we meet with some excellent examples of nests which, from the materials used and the way in which they are fashioned, approach most nearly to those made by birds. Here again the male looks after the babies and his, too, is the task of making the nest if it is at all of an elaborate nature.

First of all the sticklebacks may be considered, and the best known are the three-spined " tiddler " of ponds and streams, the ten-spined form, also common in the same situations, and the fifteen-spined species of the sea. In passing, however, we may mention that the last-mentioned fish is very remarkable, owing to the fact that it is equally at home in salt and in fresh water. In the case of the three-spined stickleback, the male in spring becomes gloriously coloured and when he shines with scarlet



PARADISE FISH AND ITS BUBBLE NEST

The Chinese paradise fishes hatch their eggs in a nest of bubbles. The male inhales some air at the surface, then by exhaling below water bubbles are produced in a mass. When the female lays her eggs the male puts them in the nest.



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FISH NEST-MAKERS: BOWFIN AND LAMPREY
At breeding time the parent lampreys clear a space at the bottom of the stream and there deposit the eggs as in this drawing. Then they remove stones up-stream, and the removal disturbs the sand, which gets washed over the eggs. Above is a bowfin.

somewhere else in a very workman-like manner. The ten-spined stickleback, on the other hand, sets up a home for its young ones amongst the weeds and grasses near the bank, and the fifteen-spined form chooses a spot in a rock pool between tide marks and the elegantly constructed nest six or ten inches long usually hangs from a frond of seaweed

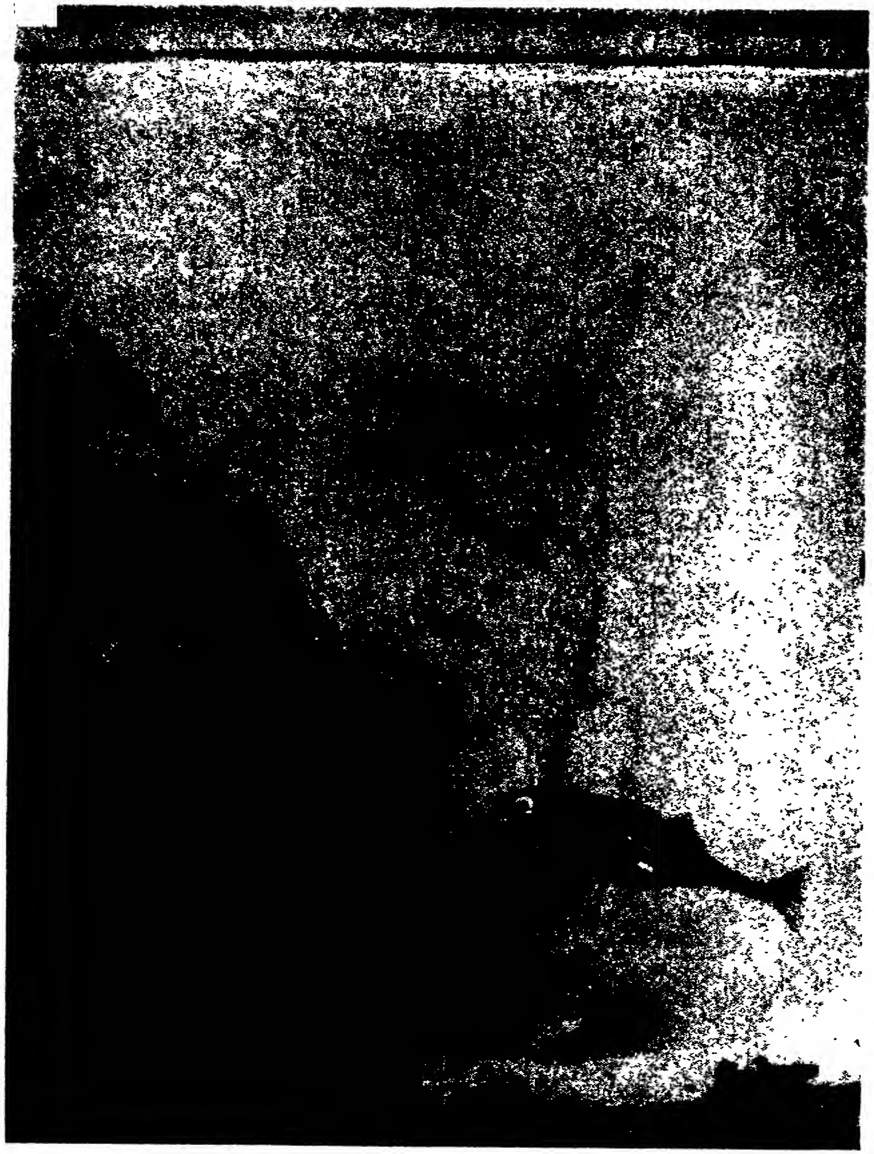
In all cases when the nest is completed it has but one opening in the side but later on after the female fish, by dint of much coaxing and caressing, has been inveigled into the nursery and has laid her eggs, she does not return by the original entrance through which she came in, but makes a new opening in the opposite side of the nest and so departs. The two orifices thus formed afterwards enable the male parent to fan a flow of water with his fins on to the developing eggs so as to keep them well aerated.

Before, however, growth can begin, the eggs have to be fertilised, and this is done by the milt (which in the case of the herring we call the soft roe), placed in the nest by the male fish.

Apparently the eggs may be deposited in instalments and sometimes more than one female fish may be induced to use the same nest.

It is not difficult for anyone to breed sticklebacks who can set up an aquarium (a glass battery jar makes a good one) with the right complement of weed to aerate the water and obviate any necessity of changing it. The great thing is to have only a very few fish in a small space and in the case of the sticklebacks after the eggs are laid it may be well, if one wishes to make certain of their safety, to leave only the male fish in the tank until they are hatched, for the females are very apt to devour them.

The small bowfin of North American rivers and lakes is as good a parent as the stickleback and has quite as interesting habits. Although the result of his labours certainly comes well within any general definition of a nest that one could frame, it savours, perhaps, of the castle as much as of the nursery pure and simple. This fish makes a clearing among the closely growing weeds by beating them down and actually biting them off, leaving a narrow entrance unblocked through which he can bring his bride and in which he takes up his position to keep away any intruders while she is depositing her eggs. Afterwards he remains on guard in the passage until these are hatched, when he still continues his parental duties, and shepherds them by swimming round them



J. J. Ward

UNDER-WATER NEST OF THE STICKLEBACK AND THE DRAMA PLAYED ABOUT IT

Springtime finds the male three-spined stickleback turning the colour of its skin bright scarlet and green. In this lover's livery he sets about collecting filaments of waterweed with which to construct a nest. The lengths of weed are woven together and fastened more firmly with a sticky substance secreted in the kidneys. The finishing touches are put in with a most admirable industry. The male then seeks a mate and endeavours to persuade her to enter the newly-built home. Here (left) we see the female below the nest making up her mind, while on the right is a deadly rival trying to lure her away to his own nest. The owner of the nest then drives him up above the nest (right), and is seen swimming out of the photograph to the left to renew his persuasions.

J. J. Ward

THE ETERNAL TRIANGLE: MALE STICKLEBACK, HIS MATE AND A DEADLY RIVAL

We have seen the first stages in the under-water drama of the stickleback's wooing in the opposite page. Now a later scene is before us where (left) the owner of the nest has just wounded and charged his insidious and persistent rival, who is seen drifting disconsolately above the nest. The female is still hovering undecided below the nest. In the right-hand photograph the rival still hovers near, despite his wounds, while the owner, his spines bristling, goes back on guard. When the female has entered the nest and laid her eggs she does not return by the same entrance, but bites a way through the other end. By means of the two holes in it a constant current of water can be driven through the nest by the male's fins while the eggs are hatching.

W. S. Berridge

THREE- AND TEN-SPINED STICKLEBACKS

While the three-spined stickleback builds its nest at the bottom, the ten-spined variety (top) also a fresh-water species, makes a home for its eggs and young near the bank among water-weeds and grasses. Sometimes eggs are deposited by the female several times, and it may even happen that more than one female will be induced to enter the same nest.

The wrasses or rock-fishes are worthy of mention on account of the mass of material which they gather together. The seaweed from a single nest at times would fill a peck measure and corals, broken shells and other things are also used.

More than one of the class of animals which we are considering make use of shells as nurseries On the one hand, the female bitterling, which is a tiny fish found in Central Europe and often kept in captivity in England, has a very long ovipositor with which she introduces her eggs into the shell of a fresh-water mussel during the lifetime of the owner by inserting it between the valves while they are gaping open. In this way the mussel is made to act as a foster-mother On the other hand, the gobies of the sea-borders use a single empty valve or a limpet shell or a crab-cart. They are interesting creatures to keep in the marine aquarium, and have the habit of coming out of the water from time to time, though not quite to the same extent as the tropical walking-fish.

EN the shell has been sought for by the male and found satisfactory, it is put by him into the position required, that is, with the convex side uppermost, to form a roof. Then the fish scoops out with its tail a depression in the sand beneath the shell and makes a small opening through which he and his mate can go in and out. Finally the house is covered with sand so that it is no longer noticeable and the grains are actually gummed to it with mucus by the male. Bubbles seem to be a curious material out of which to make a nest, but the Chinese paradise fish uses them, and the male, by taking air into his mouth on the surface of the water and expelling it again, produces these himself. The small froth-blower having busied himself in this way for some time goes in search of a wife, and when she has been found he brings her to the strange nest. As she lays her eggs they sink to the bottom one by one, and the careful husband catches them as they drop, afterwards depositing them in the nest, to which they stick. The female of the paradise fish, like that of the stickleback, is only too prone to become an unnatural mother, and is one of the enemies from which her mate has to protect the eggs and young.

Another kind of foam, which floats and supports the young in the water after they are hatched, is the secretion of the male of a species of fish inhabiting swamps in tropical Africa. The fry hang on to the nest by a special sucker-like organ which is developed on the front of their head.

The lamprey is a primitive animal sometimes called "nine-eyes" from its numerous gill openings, and in its case, as in that of some other fishes, both parents clear a space at the bottom of the river in which the eggs are laid. The lampreys do more than this—they remove even quite large stones by means of their sucker-like mouths for some little distance above the nesting-place, as we should call it in the case of birds. During the process a considerable amount of sand is washed down by the current.

which effectively covers up the eggs so that they are put quite out of sight. A finned inhabitant of a Queensland river makes matters more sure by piling large stones over its eggs. Others in South America make holes in the banks and line them with grass.

THE nesting-place of the Californian smelt is only under water when its period of usefulness is coming to an end. The parents in the nesting season take advantage of a high tide to get up on to the beach, and are left there high and dry. Their nest is a hole in the sand which they dig for the purpose, and when the eggs are deposited and covered up, the old fishes wriggle back into the water again. In a fortnight's time hatching takes place and at the next spring-tide the waves reach the nest, uncover it, and carry the young smelts back with them into the sea.

Other fishes, though they do not make a special nest, put their eggs into crevices or holes bored in rocks by molluscs, and others again do little more than guard their eggs and keep the water moving over them. The curious looking lump-sucker, with grotesque and swollen body, is a case in point and the young for some time after they are born, cling to their father by means of their sucker-like underside.

The male of the pipe fish, which is a common inhabitant of the waters round the British coast, shares with the even more striking and rarer sea-horse (occasionally found in the same seas and shown from time to time in aquaria), the distinction of having a pouch in its underside. Into this he most carefully gathers up the eggs and pockets them, so to speak, until such time as the young emerge.

W. S. Berridge

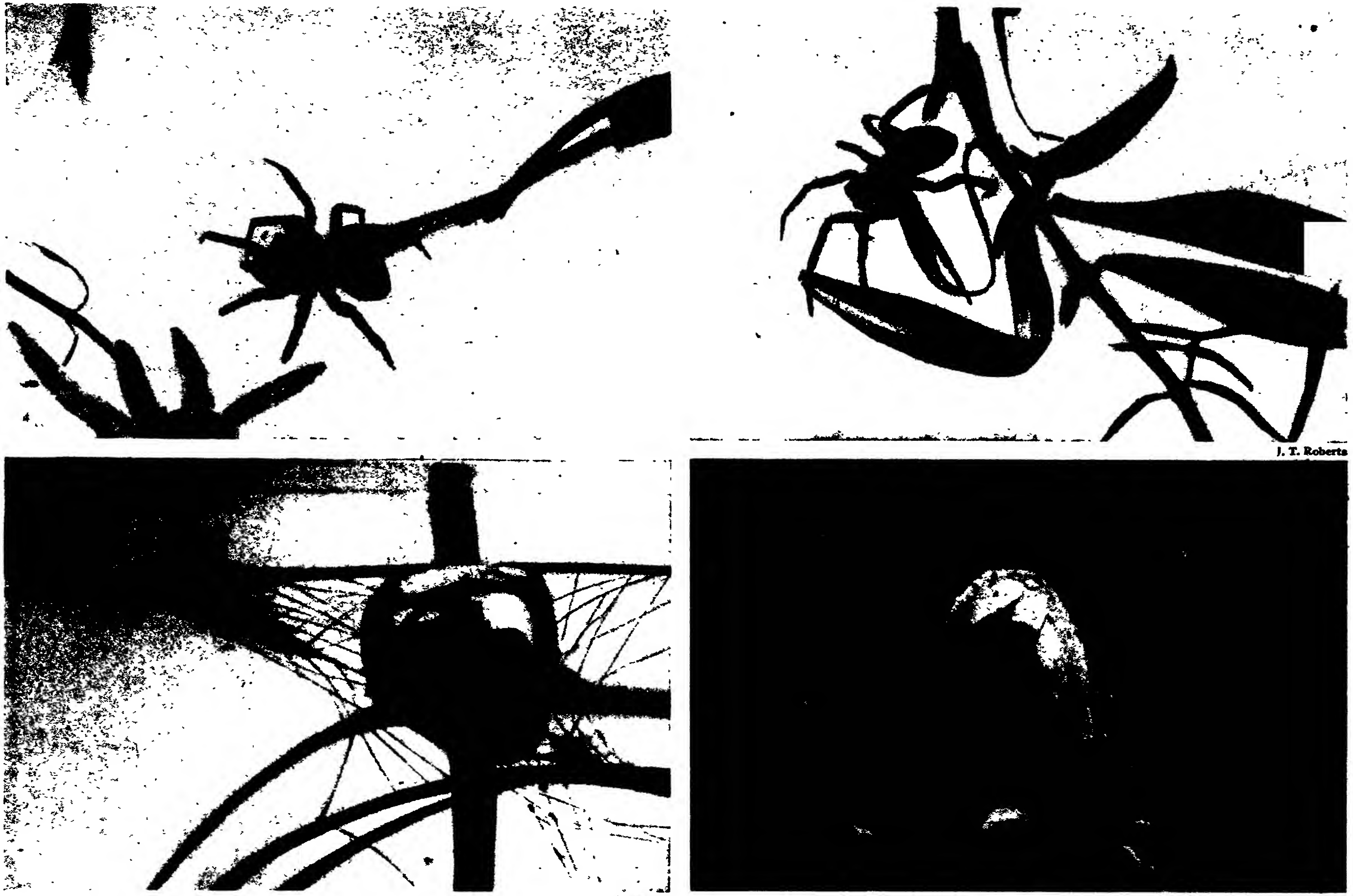
Natural History, N.Y.

FISH THAT USE SHELLS FOR NURSERIES

Butterfish are found in North American waters and lay their eggs in an oyster-shell, the female coiling herself round the mass of eggs and keeping guard (bottom). Notice that some limpets have also taken the advantage and are clinging to the inside of the upper valve or shell. Above is a sand goby using an empty shell as a nest.

The egg-cases of some marine shells are striking to look at and those of our common whelk have the appearance of a closed nest, though each egg is really in a separate compartment. The young of the fresh-water whelk are hatched inside their mother's shell which, like that of her sea cousin, is provided with a lid or door to keep out intruders.

The beautiful purple shell called the Gulf Stream snail constructs a very serviceable raft which floats on the surface of the water, and to this the eggs are attached so that they hang down into the water. The young of many bivalves spend their early days clinging to the gills of their parent within the shell.

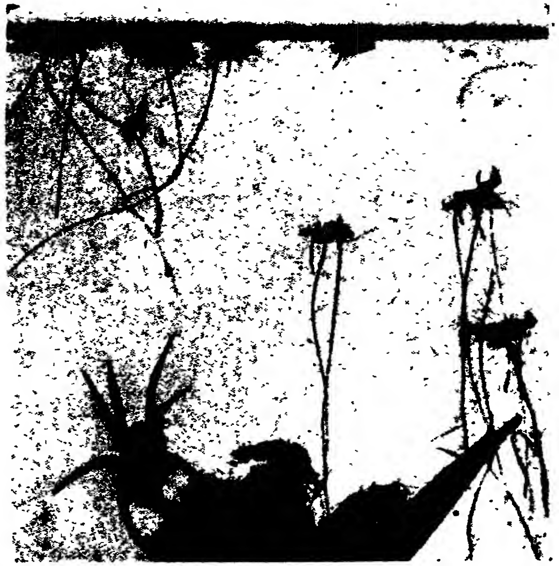


J. T. Roberts

F. W. Bond

HOW THE WATER-SPIDER SPINS ITS DIVING BELL NEST TO HOLD AIR

Some way below the surface the water-spider selects a suitable spot among the weeds as the site for its nest. It makes the nest out of silk, just as the ordinary garden spider makes its web. But in the case of the water-spider the silk is used to make a nest only, not a snare for catching food. The little creature begins operations by spinning threads from one branch of the water plant to another (top left). It may then have occasion to turn over the edge of a leaf (top right). When the construction is finished the result (bottom photographs) is thimble-shaped, and not unlike a diving bell alike in design and purpose. Troubles, however, are not over when the nest is finished, for another water-spider may try to gain possession.


Spider leaving nest


Capturing an air bubble at the surface


Diving with the bubble


Nearly home


Running down the side after releasing bubble

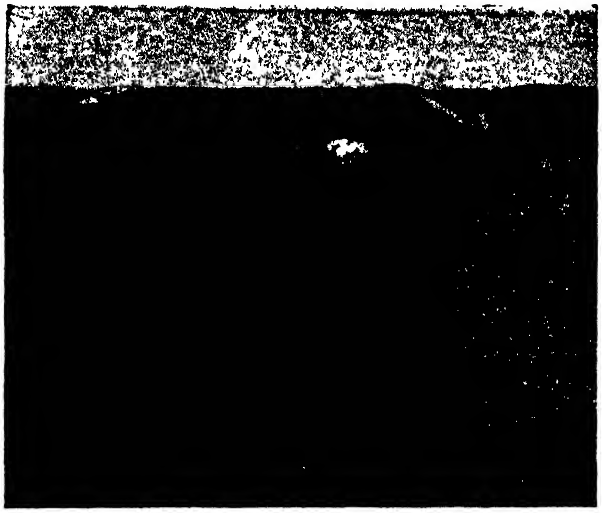

Entering the nest

PROCESS BY WHICH THE WATER-SPIDER CONTRIVES A NEST BELOW THE SURFACE

The water-spider breathes air and its young are also air-breathing from the very beginning of their lives. The problem of providing a nest for them under the water has been solved in a way as extraordinary for its ingenuity as for its simplicity. The spider, having constructed the nest (see page 652), ascends to the surface. There its hairy body is in contact with the air which clings to the hairs, when the spider goes down again, in a covering of small silver bubbles. These bubbles are released from time to time within the nest and, of course, rise to the top of it. Gradually they accumulate until the nest is full of imprisoned air where the young may develop. The above photographs by J. J. Ward show the spider's journey from nest to surface and back again.

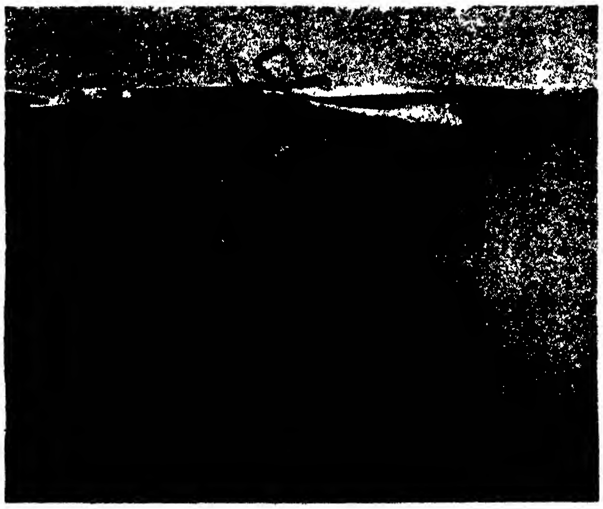
Male makes love to female inside nest

Female approaching nest to drive out another female



Female refuses to admit male to nest

She attacks the other female spider in nest



Male pulls nest to drive out female

She is driven away by her rival

ROMANTIC ADVENTURES OF A FEMALE WATER-SPIDER IN HER NEST

First of all, in this panorama of a day in the life of a female water-spider, we have the courtship (left photographs). The male (top) tries to enter the nest, but the inmate is coy and repulses him. Then he tries to entice her by pulling the nest on one side and by being generally active (centre and bottom). After his departure there arrives another female who takes a fancy to the nest and tries to drive the owner away. In the right-hand column of photographs we see her try and fail. The photographs are by J. J. Ward.

It is possible that at times they may be a nuisance and one pretty little species has a wonderful arrangement by which its children are kept in a nursery out of sight. When the female is building her shell she produces as part of each valve a little cup lined with pearly matter, and as the two cups are arranged so that the mouth of each coincides with that of its fellow, when the valves of the shell are closed the young ones are shut up completely in their shelly nursery. Some of the male shells have no sign of this, but others show a vestige of the cradle recalling the small teats in a male mammal.

One of the most interesting inhabitants of the ponds and for that matter, of aquaria, is the water-spider, which, when it is taken out of its element, resembles some land forms found under the bark of dead trees, but in water its body is studded with silver balls of the air which it carries down with it attached to the many hairs with which it is clothed. It does not make a web, but constructs a regular diving-bell some distance below the surface among the weeds, using the silk, with which it is supplied, for domestic purposes and not for producing a snare. In the diving-bell, which, of course, has the mouth downwards, the spider stores away from time to time some of the air which clings to its body, and when the eggs are laid in this remarkable arrangement the imprisoned air enables the young creatures to come to perfection without the necessity of developing even temporary gills

J. T. Roberts

WATER-SPIDER TAKING DOWN AIR TO ITS NEST

In this close view of a water-spider's nest we can see the bell-like form in which it is made. The spider descends, crawls down the side of the nest and then stores the bubbles, that are adhering to its body, inside. Notice the caterpillar that has had the misfortune to fall off some overhanging branch into the water and has been caught in some of the strands of the nest.

Among the insects, the great water beetle and its allies may be picked out as builders of nests under water The species named is the largest found in Britain with the exception of the stag beetle. Her nursery is made of silk like those of some spiders, and her spinning organs are at the end of her body, being in the form of conical tubes. When she is about to start work, she lies on her back with her last two pairs of legs amongst the weeds, and with the front ones she brings the filaments over her body. She then covers the weed on the underside with white silk, and shapes the nest as she weaves it, making it arched by pressing it with her fore-legs against the curve of her body. Having finished the top half she turns over and constructs the lower half in the same way, producing what may be described as a cocoon In this she places her eggs in regular order and closes the mouth. Then she finishes her work by making a little mast, as it were, tubular in structure, which sticks up like a periscope from a submarine, and, it is believed, helps to admit a supply of air to the eggs The so-called water-scorpion is a weird-looking

J. J. Ward

H. S. Cheavin

H. S. Cheavin

WATER SPIDER, ITS JAWS, FOOT AND SKIN

Highly magnified, the male of the water spider looks like this (top left). The top right-hand photograph shows the complicated mouth parts. Below we see the leg and foot (left), and in the right a section of the spider's skin. This is covered with long, strong hairs, and these catch the air and hold the bubbles while the spider is moving about below the surface. Only the microscope can show the intricate construction which enables this small being to live as it does—breathing air but under water.

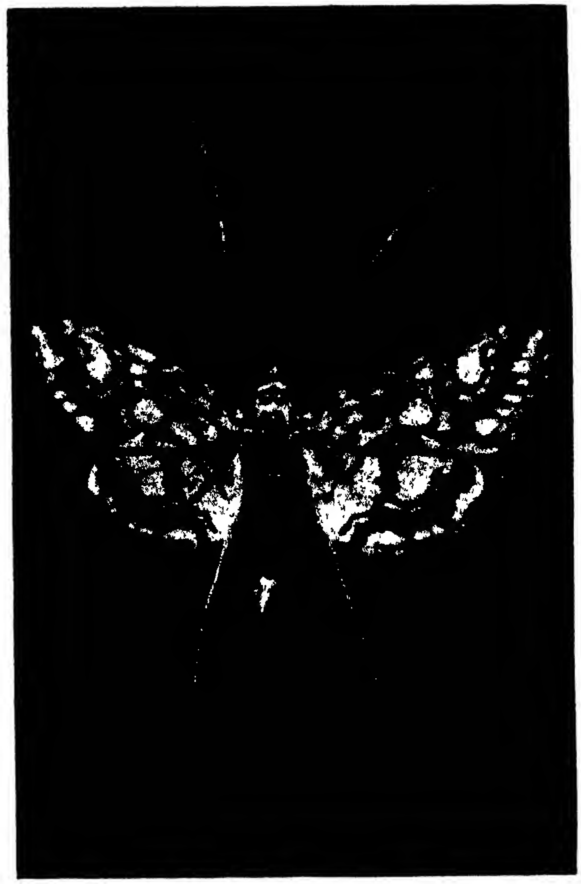
insect common in fresh water. Technically it is a big bug with a piercing blood-sucking snout. It has also a long ovipositor which enables it to put its eggs right inside the stems of water plants out of harm's way.

It seems strange, but some insects use the eggs of other larger species, not only as nurseries but as larders as well, the contents serving to nourish the young one of the raider during its growth. There is a delicate water insect allied to the ichneumon flies and fairy-flies—one of two species discovered by the late Lord Avebury in England—which may be given as an example. It has four wings, with which it swims through the water and it deposits its eggs in those of dragon-flies.

The familiar woodlice, which have been called garden shrimps from their habitat, have a relative which lives in water, and is not quite so well armoured. When the eggs are laid by the female they are retained behind plates which stand away from the underside and form a most effective brood-pouch in which the large eggs develop.

Lastly, we may mention another lowly creature, the opossum shrimp, which carries its young about with it in a special receptacle like the marsupial from which it gets its first name, or the kangaroo. In the case of the shrimp the pouch is formed by expansions of some of its numerous limbs.

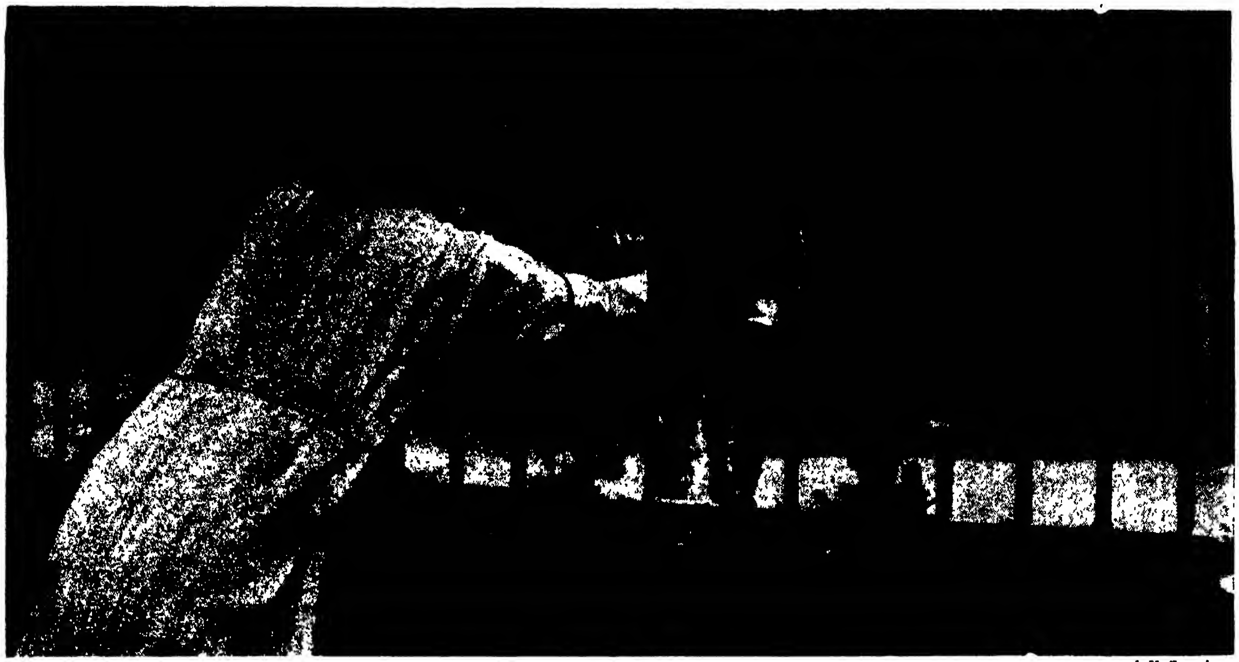
The desire to make a nest is really a manifestation of one of the strongest instincts in the animal world —the instinct to provide for the next generation and the continuance of the race. The nest is a fortress for the new life, growing up to replace the old—a pledge of the will to live.



J. J. Ward

BROWN CHINA MARK MOTH AND ITS AQUATIC LARVAE

The brown china mark moth (top) spends the first part of its life below water. The larvae (bottom left), as soon as they have hatched, make for themselves coverings of pieces of pond weed, and while within them can breathe air. In the bottom left photograph two of these coverings are seen with one end of a larva protruding from the lower. The dark coiled body above is that of a leech The right-hand photograph shows the pupa cases whence the developed creatures will emerge attached to some pond weed.



J. E. Saunders

Neville Kingston

GETTING WILD ANIMALS USED TO HUMAN HANDLING

To be able to handle a leopard it is necessary to catch the animal very young and accustom it to the scent and sight and touch of men before it has tasted the freedom of the wild. This young leopard (bottom), reposing quietly in its keeper's arms, has become accustomed to wearing a collar and chain like any dog. But it is never possible to be quite sure of even a young leopard's temper, individuals differing tremendously. What a feat it is, then, to take a bone from the very jaws of a full-grown leopard (top). Both animals here are African.

Chapter LXI

The Taming of the Wild

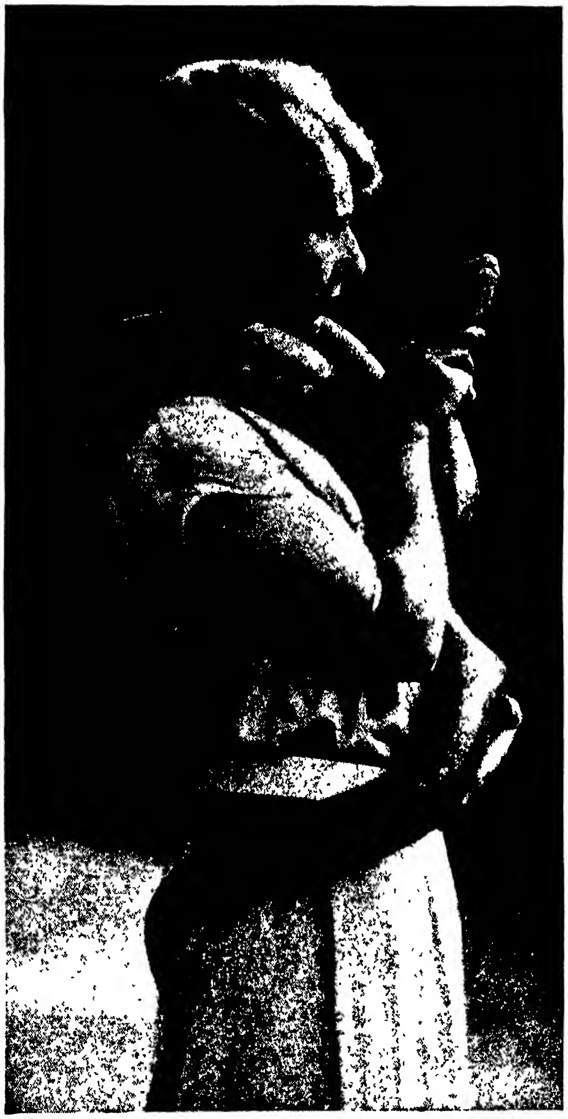
By G. M. Vevers

Superintendent of the London Zoological Society's Gardens

ALTHOUGH a zoological garden is primarily intended as a place where wild animals may be seen and studied in captivity and is not an institution for the training or taming of the exhibits, experience has shown that individual creatures which by association with human beings have become tame and are accustomed to being handled every day have a much longer expectation of life than others which resent the advances of man and do little but eat and brood upon their captivity. The latter readily fall a prey to one of the most distressing of all the maladies which may attack an animal in captivity. This, for want of a better name, may be called "cage ennui," and is the precursor of a multitude of mental and physical infirmities.

The solitary animal, above all, is most subject to this disease, and whenever possible it is the custom of zoos all over the world to try to exhibit pairs or groups of animals and not single specimens. In some cases, of course, this is found to be impossible, as when an animal has been for many years the sole occupant of a cage he is apt to regard any intrusion upon his privacy with active resentment. Tigers, as a rule, come under this category, and unless paired up in extreme youth seem to prefer solitary confinement. Lions, on the other hand, are much more friendly in disposition towards one another, and provided that a partner of the opposite sex is chosen the age or period of captivity seems to matter very little.

Taken as a whole, the anthropoid apes in confinement need the companionship of man or their own kind more than any other creature. Indeed, it is almost impossible for anyone to bring up a young gorilla unless it is treated more or less like a human child. These creatures become so deeply attached and dependent upon their keepers that even separation of a temporary nature causes them extreme mental anguish, and a change of ownership is almost invariably followed by the animal's death. The classical example of gorilla attachment was that of the famous John Daniel I to his owner, Miss Alyse Cunningham, who brought him home from Africa herself and took him into her flat in Sloane Street, where he was treated as one of the family. For many months John at the window was a familiar figure to passers-by in Sloane Street, but a tempting offer came from America, and John crossed the Atlantic, only to die of a broken heart a few days after his arrival in New York.



J. E. Saunders

WEARING A CUBAN BOA

Snakes are not so hard to tame as might be supposed, and even so large a one as this will enjoy being handled by someone to whom it is used. But it should be remembered that the snake has only to contract its coils to strangle its friend.

Animals vary very much in intelligence, and it naturally follows that the more intelligent the animal, the more readily it is tamed and comes to look for human sympathy and companionship.

The state of mind of a wild animal when brought into captivity depends to a great extent upon its age and the manner of its capture. If taken young, before it has started a life of independence, or if it is still under the protection of its parent, an animal will usually take readily to human beings, and will easily adapt itself to the conditions of captivity. If, on the other hand, an animal is taken in maturity or old age, after living a life of freedom, it starts its new existence with an instinctive hatred of its captors, and many months of patient training and

J. M. Saunders

FEEDING THE SHY GIRAFFE AT NECK'S AND ARM'S LENGTH

One advantage of the giraffe's long neck is that it can accept food from the human hand and, at the same time, keep the greater part of itself a comfortable distance away. Notice that the animal stands so high at the shoulder that even with the neck horizontal the end of its nose only just reaches the morsel held at the full stretch of the arm above the donor's head. In a wild state, the animal feeds largely on leaves and has to spread its forelegs wide if it wishes to graze.

persuasion are sometimes necessary before it can be approached without arousing panic in its mind or the desire to harm its keeper in its anxiety to escape or defend itself. Apart, therefore, from the risks run in their upbringing—for immature creatures are more delicate and susceptible to disease than older ones—it would seem that young animals are, on the whole, more suitable to bring into captivity than older ones which have experienced freedom in the wilds, and to which captivity must be far more of an ordeal than it is to a younger animal. Young animals, moreover, are more receptive to sympathy, whereas fully-grown creatures, unless they are in pain or suffering from some disease, are usually indifferent to human blandishment.

In dealing with wild animals it is not merely necessary to have a knowledge of their habits and modes of life as a whole, but it is very necessary to study each individual creature separately in order to have a complete understanding of its psychology and the inner processes of its mind. No two apes, for instance, are alike in their intelligence or in the amount of reasoning power of which they are capable, and again there is a complete difference in the attitude of mind of the two sexes. In relation to this, it is of the highest importance to know and to recognize when the age of puberty takes place, especially in male animals, for in most cases there is a distinct change of outlook at this time, and the animal which has been handled with impunity by all and sundry may, in an instant, under the subtle influence of sex, turn upon those whom it has previously regarded with affection. Bears, with very few exceptions, come under this heading, and, surprisingly enough, so do the manlike apes, and it is the exception rather than the rule for any chimpanzee to be regarded as safe after the age of seven or eight, at which time they attain sexual maturity.

In recent years a great change has taken place in the attitude of mankind to animals of all descriptions, and in this and most other countries dumb creatures are treated in a much more humane manner than they used to be. In the old days man tried to subjugate animals more by fear and cruelty than by patience and kindly treatment. These old methods, apart from being cruel and therefore to be deprecated, sooner or later almost invariably reacted upon the trainer with disastrous results. Nowadays, the first endeavour of every successful animal trainer is to establish by friendly methods a complete understanding between himself and his pupils.

The pioneer of the modern method of training and exhibiting animals was the late Carl Hagenbeck, of Hamburg. His work is to-day being carried on by his two sons, who not only control the gardens at Stellingen, but also are responsible for several large travelling circuses and menageries. In order to demonstrate that the animals are trained in a humane manner the Hagenbecks admit the public daily to their animal training school on payment of a very small entrance fee. By this means they not only provide an interesting and instructive entertainment, but they also place themselves beyond criticism.

In his book entitled "Beasts and Men" Carl Hagenbeck vividly describes the horror with which he viewed the old methods of training animals and the barbarous shows which were the outcome of ignorance and cruelty. Training in those days, if it can be so called, he states, "consisted in terrifying the animals with whips and red-hot irons, so that at the very sight of these implements they would fly through the cage and, in doing so, would leap over whatever obstacle was placed in their path." It was a common sight to see "trained" lions whose whiskers had been scorched off and who were frightfully burned about their mouths, and it was no unusual thing for the trainers to be attacked and torn to pieces. Nor could one blame the animals, for their lives were rendered insupportable and they merely acted in self-defence. By instituting the practice of studying the character of each individual animal, Hagenbeck succeeded in achieving by humane and intelligent methods incalculably better results than the old trainers had obtained by means of their implements of torture.

For the circus ring animals have to be chosen with great discrimination, for not every lion or tiger can be taught to perform tricks, however patient his trainer. But it is a mistake to suppose that all carnivora are naturally savage; nearly all are amenable to kind treatment and after a short while learn the lesson of obedience. It must not be thought, however, that the modern trainer, with his knowledge of animal psychology and his humane methods of dealing with his pupils, does not run the risk of being mauled. It is true that the risk he takes is very much less than in the case of the so-called trainers of the last century, but there is always a chance of a sudden outburst of temper due to an inborn natural ferocity; and, knowing this, one cannot but admire the man who, for his livelihood and, in most cases, for the love of animals, takes his life in his hands twice daily and enters into a den of lions armed only with a whip and a wallet containing a few pieces of meat. The former is used mainly to indicate the position which the animal is to take up and the exercises which it is to go through, and the meat a reward for obedience.

Neville Kingston

INTRODUCING THE LION CUB TO THE TIGER CUB

One of the most difficult tasks connected with the taming and keeping of wild animals is getting two different species of the large carnivora to dwell together. Unless the introduction is effected in extreme youth, satisfactory results are almost impossible. Here we see a keeper presenting a very young lion to a very young tiger. The latter, probably because it feels at a disadvantage in the basket and, anyhow, resents confinement, is furious when the lid is raised. The lion, however, is only filled with curiosity as to the contents of this hamper.

J. E. Saunders

WHEN HUMAN SENSE AND KINDNESS WIN CONFIDENCE AND TRUST

No child could rest more confidently or comfortably in its nurse's arms than this young fox which reclines, yawning, upon its friend's arm. Every detail of its pose—up-curled tongue, the forepaws resting contentedly on the lady's arm while the hind legs stand on one of her hands—shows ease. This animal, like the leopard in page 658, has a collar and chain in case of need. That bears are treacherous is notorious among those who have to do with them, and, while the young ones can be taught with patience, yet there comes a time when the animal is adult, and can be no more trusted. But, all the same, a bear can be pleasant enough, as our right-hand photograph shows.

Nevill : Kingston

TAME CLOUDED LEOPARD: BABY ALLIGATOR IN THE DENTIST'S HANDS

Lying peaceably in the keeper's arms, you would hardly know the so-called clouded leopard for the fierce creature it is in its life among the trees of the Sumatran forests. This is the most arboreal of all the large cat tribe, and its name is misleading, for it is not a true leopard, but an isolated species. It is also sometimes, and as erroneously, called the clouded tiger, though it is no more tiger than leopard. Notice the strong steel-handled chain attached to a stout collar, giving quite a domesticated air to the animal. The right-hand photograph shows a little crocodile which was suffering with the toothache. Its jaws, carefully propped open, are being examined to see if any teeth need extraction.

J. E. Saunders

ZOO BIRDS INTIMATE WITH THOSE WHO FEED THEM

While birds are not easy to train most birds learn to tolerate those who feed them. A king vulture at the London Zoo was used to being fed by a certain lady. It formed the strange habit of nibbling at her stocking and trying to pull it off. This, too, was a bird which had previously been thought to be virtually untameable. In the lower photograph is a young hornbill on its first day at the Zoo. It became used to human society on its journey from the East and was quite ready, after a little coaxing, to feed from the lips of a bird lover.

J. E Saunders

CRUEL TALONS AND DANGEROUS BEAKS TAMED BY KINDNESS AND PATIENCE

One Fellow of the Royal Zoological Society, a lady, has been successful in her efforts to tame the fiercest eagles and also some vultures which had been considered to be quite unapproachable. Thus do the ideas of animals slowly change under the influence of time and experience. Wild creatures are no longer so glibly labelled tame or fierce as formerly. Below is a Chilean sea-eagle feeding quietly from the hand which it could, if it wished, tear open with a stroke of beak or claw while above is a Pondicherry vulture lying contentedly on its back to be fed.

recently that Polar bears were introduced into the circus. This was achieved by Carl Hagenbeck's brother, Wilhelm, after a great deal of care and patience. Before this it was considered that Polar bears were untrainable, but he succeeded in training a troupe of seven to go through quite an exacting performance.

Carl Hagenbeck was a great adept at introducing numbers of different species of savage animals together in the same cage. This, when accomplished, forms a very attractive exhibit, but it requires weeks, sometimes months, of patient preparation for the animals have to see each other through bars before they

To indicate how rarely serious accidents occur in dealing with performing animals, Hagenbeck, in his memoirs, recalls only two cases of men being mauled during the whole of his experience as an animal trainer. One of these was an outsider from the audience who managed to make his way into a den of lions and tigers, and who barely escaped with his life, and the other was his brother-in-law, who received a severe mauling at the hands of a black bear against whom he had repeatedly been warned.

BEARS are notoriously treacherous animals, and although they have been trained as performing animals from time immemorial, the time comes when they can no longer be trusted, and they have been undoubtedly responsible for more accidents in zoos, circuses, and elsewhere than any other animal. This uncertain trait in the character of the bear is traditional in the countries in which these creatures flourish and become associated with human beings. Everyone who is familiar with the writings of Kipling and who has read "The Truce of the Bear" in his "Songs of the Five Nations" will realize the horrible treachery of which this beast is capable.

The performing bear referred to above is, of course, the common brown bear which inhabits Northern Europe and Asia. It was not until

J. E. Saunders

LARGE AND SMALL RELATIVES OF THE CAT

All cats like being scratched between the ears, and even so large a one as the cheetah is quite agreeable so long as the scratcher is familiar to it. The animal is thrusting up its head against the pressure of the hand with evident enjoyment. Above, we see a genet, a creature closely allied to the civet cats. Genets are smaller than domestic cats.

DIAMOND PYTHON SHOWS AFFECTION FOR ITS KEEPER

Since modern conditions prevailed in the reptile house at the London Zoological Gardens, the lot of the snakes has been far happier and the mortality has substantially decreased. Artificial sunlight and electric heating combine with tropical plants to make conditions as ideal as possible. Snakes like heat and become sluggish and refuse food when cold. They are not difficult to tame and will soon learn to recognize the call to food. This diamond python is treating its keeper to a snake "kiss."

are allowed to be introduced together into the same cage; and they have to be watched very carefully for some time after, and separation at feeding-time is very often a necessity. Hagenbeck, however, succeeded in bringing together many different kinds of animals, and it was no uncommon sight in pre-war days at Stellingen to see a group of lions, tigers, bears and hyenas all together in the same enclosure, apparently taking no exception to or even notice of each other.

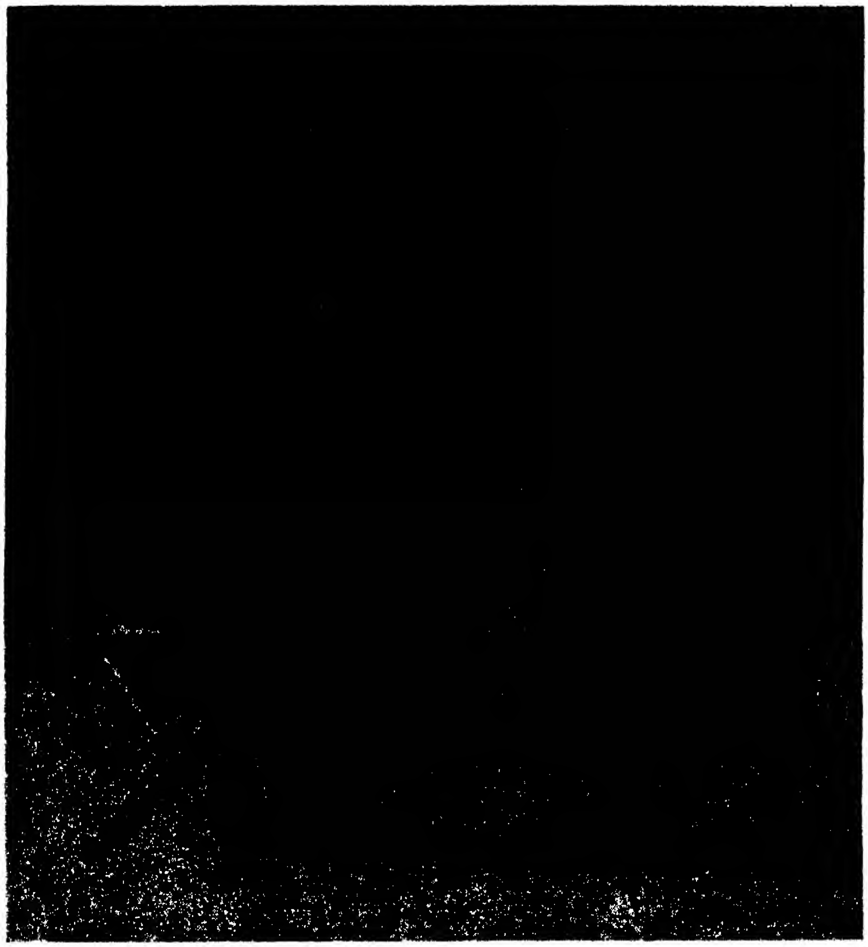
A PLEASANT sight which is sometimes seen in zoos is a group of lion cubs, or even a full-grown lion, playing together with a small fox-terrier bitch which has acted as the foster-mother. This is sometimes regarded as cruel, but one has never heard of a foster bitch being hurt by her charges.

Carl Hagenbeck will also go down to posterity as the first man to show animals on the panorama or terrace system which not only reproduces, as far as possible, the natural surroundings of various groups, but also gives the onlooker a comprehensive view of the fauna of the different continents more or less at a glance. The Mappin Terraces and Monkey Hill at the London Zoo are both constructed on the Hagenbeck principle, and the results obtained, both from the point of view of the health and fecundity of the animals, as well as from the visitors' standpoint, have proved eminently satisfactory.

More recently further improvements have been made in the housing of delicate animals from tropical and sub-tropical countries. For example, in the old days, in practically every zoo, monkeys used to be kept under hot-house conditions; that is to say, their cages were housed in a glass building which was heated at a constant high temperature throughout the year. The result of this was that from time to time epidemics of tubercle and enteritis used to decimate the population of this type of house, and those animals which were fortunate enough to escape infection sooner or later were stricken with rickets and cage paralysis, and ended their days in misery on the floors of their cages.

The modern monkey house is the exact antithesis to this old type of building. Lofty and well ventilated, with every interior cage communicating with an open-air one by means of a door which can be easily worked by the inmates of the house, with artificially-warmed floors and ultra-violet ray lamps for winter use and the roof constructed of "vitaglass" to catch every ray of sunlight possible, the modern monkey house from the hygienic standpoint is as up to date as the most recently constructed of our hospital wards.

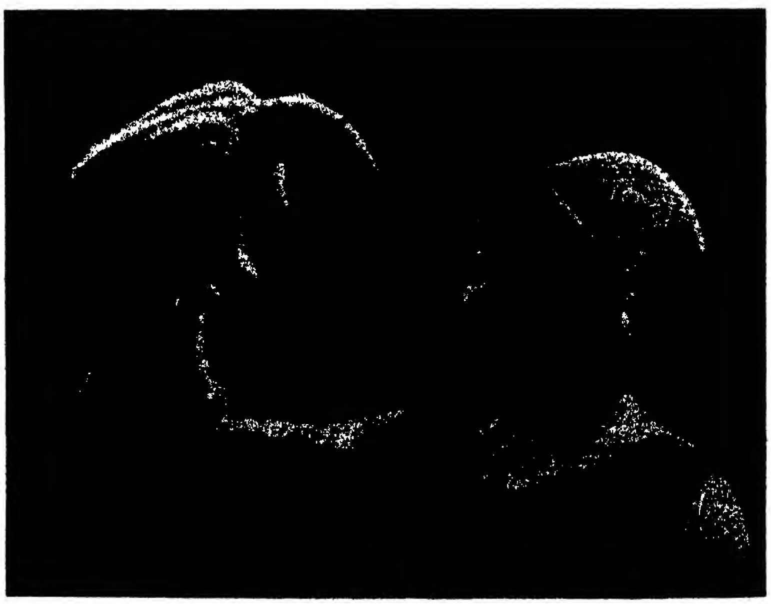
Perhaps the most wonderful house in any zoo in the world is the new reptile house at the London Zoo. It cost over £60,000 to construct and is heated and lighted entirely by electricity. Everything possible



cannot be tamed. Snakes, as a rule, of a size that can be carried, enjoy being handled by man and can be trained to recognize a call to food. Even alligators can be trained and exhibited, and there is an enormous lizard now living in the reptile house at the London Zoo which answers to the name of "Sumbawa" and follows its keeper about like a dog (see pages 32 to 44).

Birds, with the exception perhaps of parrots, are not easy to train to do tricks, but there are certain species of hornbills which exhibit unusual intelligence and very soon become friendly with those looking after them, and can be trained to do a series of amusing tricks provided food of some description is at the end of each performance. There are several examples of these birds at present living in the new bird house at the London Zoo, and each has a different set of tricks which it goes through with its keeper every afternoon at feeding time. Occasionally, individual birds of other species show themselves adaptable to training and many, of course, enjoy being handled and perch on the

has been done to reproduce the conditions under which all kinds of reptiles live in nature. The warmth of each den is controlled thermostatically and the heat can be increased or decreased according to the individual creature which, for the time being, may occupy any particular enclosure or den. Similarly, every compartment is fitted with an artificial sun which can be turned on when the weather is dull or whenever any of the reptiles are sluggish and refuse to feed, for most snakes and lizards will not feed unless they are thoroughly warmed up beforehand. Painted backgrounds and tropical plants all help to make the captives in this wonderful house feel more at home and, during the past twelve months in which it was opened there was an apparent decrease in the mortality of the inhabitants as compared with that of previous years, and, furthermore that their general condition had very plainly improved to an enormous extent. It is a mistake to suppose that reptiles



Saunders

FRIENDLY ANTEATER AND HORNBILL

After becoming accustomed to its friend a captive anteater (bottom) consents to be lifted up. Above is an Indian hornbill. The lady feeding it is careful to steady with her foot the camp stool on which the bird is perched. Attention to detail and avoidance of shock to the animal are essentials in taming the wild.

person feeding them; but it may be taken as a rule that bird intelligence is not of a high order, although some birds, such as parrots, ravens, mynahs, and jackdaws have the imitative faculty very well developed.

Of recent years some strange friendships with birds have been made at the Zoo, and one lady Fellow of the Society has succeeded in taming not only some of the fiercest eagles but also several vultures which have hitherto been regarded as quite unapproachable.

treatment of a sick animal is not an easy matter, as it presents the same difficulties of diagnosis which confront the physician when dealing with a young child—for, like a child, the animal cannot tell you what is wrong with it or where the pain is, unless there is an obvious injury. Furthermore, most animals resent any form of physical examination, and it is generally wiser to make a guess at the diagnosis from the more obvious symptoms than to distress and perhaps accentuate the disease or disability from which the animal is suffering by attempting manual examination.

This is most certainly the case with such animals as small antelope, deer and other such timid creatures, for any physical interference on the part of the animal doctor generally results in these cases in one or more broken leg bones. In such cases it is usual to keep the animal without water for some hours until it is thirsty and then put a dose of medicine in its drinking trough.

There are certain routine operations which are carried out at all zoos from time to time. These include cutting the claws of the large carnivora which, in captivity, are liable to grow into the pads and cause pain and lameness, filing or cutting the beaver's teeth, which also become overgrown owing to lack of use, and the reduction of the hoofs of certain ungulates, such as zebras, which from time to time get unavoidably overgrown through lack of exercise upon a suitable soil.

W. S. Berridge

A HOODED GOSHAWK

Training birds of prey to hunt for man is an ancient art. Here is a goshawk hooded and ready to be taken out upon the falconer's wrist. When suitable quarry is espied the hood is removed and the hawk, quickly noting its prey, flies off in pursuit.

Professor Bastian Schmid

A FROG HYPNOTISED

Man's power to hypnotise animals is most remarkable. It has been found that purely mechanical influence will produce the hypnosis. This frog, for instance, was held vertically and then laid down. Its limbs could then be placed in all sorts of attitudes.

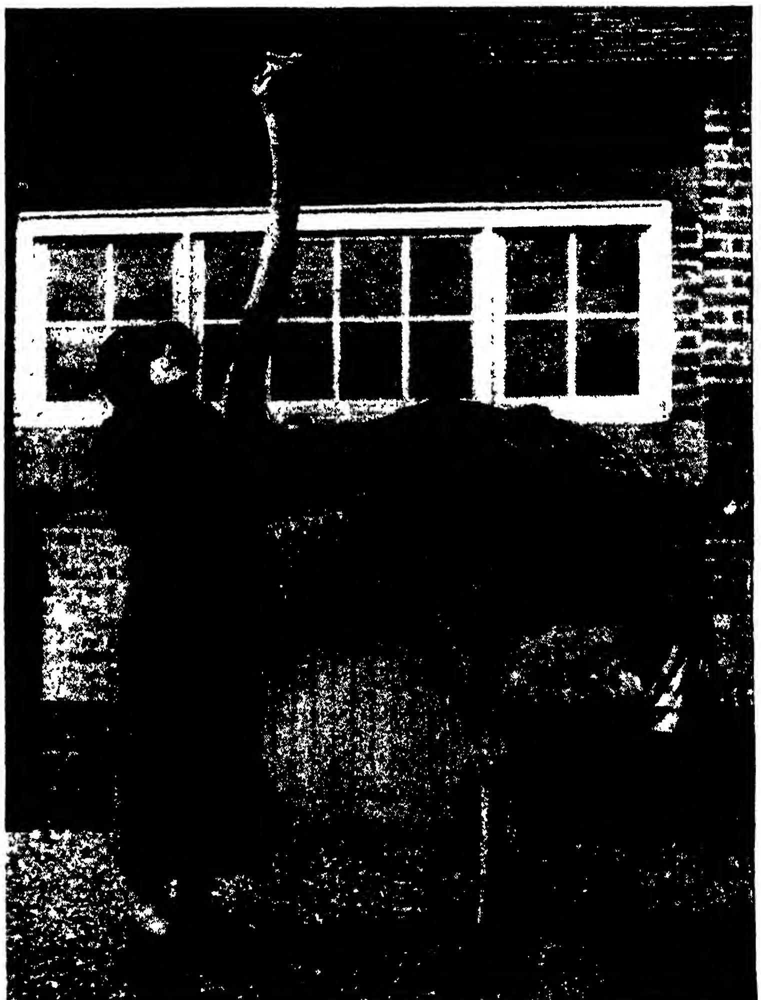
W. S. Berridge

The ultimate health and happiness of an animal in captivity depend very largely on the care exercised by those employed to effect its capture and look after it during the time which it spends on the journey to the zoo. Early impressions of human treatment and association are very much liable to influence the animal's behaviour during its first years of captivity. These points are dealt with in the chapter entitled "How Wild Animals are Caught" in this work, pages 587 to 601.

In former days it was the practice in cutting the claws of lions, tigers and leopards to cast a noose round the victim's leg and draw it to the bars, when the offending claw could be clipped with a large pair of cutting pliers. Now a much more humane and scientific method is adopted. The patient is enticed into a specially constructed anaesthetic box which is to all intents and purposes airtight. Into this a mixture of warm chloroform and ether vapour is pumped out of a large Shipway apparatus. The stages of anaesthesia in the animal are observed through protected windows in the sides and top of the box. When anaesthesia is complete the slides at each end of the box are opened and the creature's toe-nails are clipped in turn. It usually takes a little less than half an hour from the commencement of anaesthesia until the animal is thoroughly awake once more.

In running a zoological collection, the watchword should be "Prevention is better than cure." This axiom not only applies to the health of the animals but also to their management, for many ugly accidents can be prevented by foresight and common sense.

All of which goes to prove that the accumulated experience of man, together with an ever-increasing knowledge of the nature and habits of living creatures, has resulted in a scientific attitude of mind being brought to bear upon the many problems which are presented by animals living in captivity. The present results are good, but if the same attitude is maintained in the future a still happier existence for all captive creatures is certainly going to be ensured.



J. E. Saunders

PLACID OSTRICH AND WILDLY KICKING ZEBRA

While an ostrich (bottom) can be accustomed to human beings without much fuss, the breaking in of a zebra (top) is a very different affair. It takes several men to rope the wildly struggling animal, and a long and carefully conducted training has to be carried out before anything like tameness is achieved.

Chapter LXII

Animal Slayers of the Snakes

By W. P. Pycraft

Author of "The Courtship of Animals"

Snakes, the world over, have an evil name: to kill one, anywhere, is deemed a meritorious act. So intense, indeed, is this blind hatred that creatures which, by force of circumstances over which they have no control, have come to assume the semblance of snakes are made to share the same fate, death, whenever the opportunity offers. A girl once told me that though she knew the blind-worm was perfectly harmless, and no snake, yet she always killed one when she saw it, because, forsooth, it looked like a snake. Could any more fatuous reason be offered in excuse for such wanton folly?

It is assumed that all snakes are, and must be, venomous; and that, furthermore, all are viciously aggressive. This, however, is very far from being true, for even those with the most deadly bite will reserve their venom for its legitimate purpose as long as is consistent with their safety.

But the human race, which in so far as the civilized section is concerned, prides itself on its intelligence, is not the only, nor the principal, enemy of snakes, for animals of all sorts kill and eat them whenever possible. Some, indeed, contrive to subsist mainly on snake-meat, and among these the most deadly of all their foes are—snakes!

It seems strange indeed that snake should eat snake, but such is the case. It is not that any snake will fall upon his neighbour and devour him, if he can, but that there are some species which have persistently and of set purpose turned "snake-eaters." The largest and most formidable of these is the hamadryad, or snake-eating cobra, or king-cobra, a species which ranges from India to South China, and attains to a length of twelve feet or more. Its food seems to consist entirely of other snakes. The dreaded krait, which causes more deaths in India from snake-bite than any other snake, feeds chiefly on rats and snakes. It is very common in Bengal and Southern India, and displays an uncanny fondness for creeping into houses, hence the great number of its human victims. The coral-snake of tropical South America feeds chiefly on worms and small burrowing snakes. This species, nearly a yard long, is remarkable for the brilliancy of its coloration, consisting of alternate rings of coral-red and black—a warning-coloration, and a fine example of mimicry, for it is quite harmless as is shown by the fact that, for "cooling purposes," it is sometimes worn by ladies round their necks!

It may seem strange that snake should eat snake, passing by other possible victims in the hunt for snake-meat. But it is no more so than that bird should eat bird, as do the hawks. Whether the hamadryad eats those of its own species is not known. Probably it does not, unless the adults snap up youngsters that come in their way; for contrary to the general belief, snakes are not immune from snake-venom, even of their own, if introduced artificially into their blood. And this being so, a full-grown hamadryad would probably avoid any quarrel with one of his own kind, though doubtless he would not hesitate to tackle any other poisonous species, since cobra venom is somewhere about sixteen times more powerful than any other.

MARSH MONGOOSE, SLAYER OF ADDERS

Of the various kinds of mongoose inhabiting Africa the marsh mongoose is partly aquatic in its habit of life, and is found, as its name suggests, in swampy places. Besides snakes, it eats frogs and fresh-water crabs. It is famed as a great killer of puff-adders.

It is not a little surprising to find that there are many beasts and birds which kill and eat snakes, and many of them are said to be immune from snake poison. The mongoose, the hedgehog and the pig are numbered among these fortunate ones.

Much has been written about the mongoose in this connexion, but a great deal of it is pure guess-work, or based on "travellers' tales." Thus Pliny told his contemporaries that the mongoose, or ichneumon

MOLE SNAPS THE BACKBONE OF AN ADDER WITH ITS STRONG TEETH

While thinking of animals that kill snakes it would hardly occur to many people that so apparently innocuous a creature as the mole should be numbered among them. Yet this remarkable photograph shows a mole in the act of biting through the spine of a viper and doing it with such speed that the snake has no chance to retaliate. It should be remembered that the spinal column of an adder is a very delicate thing and the mole's muscular development is quite out of proportion to its bulk—the average length being about six inches.

first coats its body with mud, in which it wallows, and with this armour can defy the serpent. Topsell improves upon this. "It burrows," he tells us, "in the sand and when the aspe espyeth her threatening rage, presently turning about her taile provoketh the ichneumon to combate, and with an open mouth and lofty head doth enter the list to her owne perdition. For the ichneumon, being nothing afraid of this great bravado, receiveth the encounter, and taking the head of the aspe in his mouth, biteth that off to prevent the casting out of her poison." A more spirited and more accurate account of one of these encounters has been given by Mr. Rudyard Kipling in his story of Rikki-tiki!

Modern observers, like Sir E. Tennant, commenting on the widespread belief that should a mongoose be bitten it immediately rushes off to eat the leaves of some plant which provides an antidote to the poison, remarks: "If the ichneumon"—a name often used instead of mongoose—"were inspired by that courage which would result from the consciousness of security, it would be so indifferent to the bite of the serpent, that we might conclude that, both in its approaches and its assault, it would be utterly careless as to the precise mode of attack.

"Such, however, is far from being the case, and next to its audacity nothing could be more surprising than the adroitness with which it escapes the spring of the snake under a due sense of danger, and the cunning with which it makes its arrangements to leap upon the back and fasten its teeth in the head of the cobra. It is this display of instinctive ingenuity that Lucan celebrates where he paints the ichneumon diverting the attention of the asp by the motion of his bushy tail, and then seizing it in the midst of its confusion."

THAT the mongoose is immune from the poison and is therefore unconscious of any risk attending his attack seems to be shown by a story told by the late President Roosevelt, which was told to him by his friend Tarlton when he was hunting with him in South Africa. He says "Tarlton told me an interesting anecdote of a white-tailed mongoose and a snake. The mongoose was an inmate of the house where he dwelt with his brother, and was quite tame. One day they brought in a rather small puff-adder, less than two feet long, put it on the floor and showed it to the mongoose. Instantly the latter sprang towards the snake, every hair on its body and tail on end, and halted five feet away, while the snake lay in coils like the thong of a whip, its head turned towards the mongoose. Both were motionless for a moment. Then suddenly the mongoose seemed to lose all its excitement; its hair smoothed down and it trotted quickly up to the snake, seized it by the middle of the back—it always devoured its food with savage ferocity—and settled down comfortably to its meal.

SECRETARY BIRD THAT STAMPS SNAKES TO DEATH AND THEN SWALLOWS THEM

Throughout South and East Africa there is to be found a winged slayer of the snakes—the secretary bird. It gets its name from the long feathers on the head which rather resemble quill pens stuck behind the human ear. This crest the bird erects when in conflict with a snake. Its custom is to stamp the snake's life out of it with the powerful legs, and great agility is shown in avoiding the deadly bites, the wings apparently playing the part of shields. The bird stands more than four feet high and is a strong flier.

OPOSSUM HUNTS AND KILLS A SNAKE IN THE WOODS

Deadly as their poison may be, the snakes of America may have cause to regret meeting an opossum. Above we witness an encounter in the woods between an opossum and a mocassin snake. The 'possum stalked its prey round the end of a fallen tree trunk and then jumped swiftly with fatal results for the snake. Below we see the corpse laid across the bole while the opossum prepares to make a good meal out of its dangerous capture. Snakes are, on the whole, delicate in structure and it does not take a great bite to dislocate their backbones.

W. S. Berridge

EGYPTIAN MONGOOSE AND SHORT-TAILED MONGOOSE FROM THE MALAY STATES

Many legends have grown up about the mongoose, and it is supposed to be immune from the effects of snake-bite. But it seems certain that, on the rare occasions when a mongoose, through age or infirmity, does get bitten it dies. The thick fur helps to save the little animal for when this is fluffed out the snake may bury its fangs in hair without even touching flesh. But the mongoose relies mostly on its speed. Besides snakes, the mongoose eats rats, mice, birds and also fruit. Below is the Egyptian mongoose and above the short-tailed species.

Like lightning the snake's head whipped round; it drove its fangs deep into the snout or lip of the mongoose, hung on for a moment and then repeated the blow. The mongoose paid not the least attention, but went on munching the snake's body, severed its backbone at once, and then ate it all up, head, fangs, poison, and everything, and it never showed a sign of having received any damage in this encounter. I had always understood that the mongoose owed its safety to its agility in avoiding the snake's stroke, and I can offer no explanation of this particular incident."

The little hedgehog is a snake-eater. Its method of attack has been watched in captive specimens. When a snake, poisonous or otherwise, is placed in its enclosure it is found that the hedgehog's plan is to snap quickly, and then, instantaneously to present its spiny back to the reptile, which, if poisonous, strikes at the spines and expends its poison uselessly. The harmless slow-worm is dealt with in exactly the same way, showing that the attacker takes no chances!

The battles between hedgehogs and snakes have been recounted again and again, from ancient times. Topsell gives a picturesque account of such an encounter. "There is," he says, "mortal hatred between the serpent and the hedgehog, the serpent seeketh out the hedgehog's den, and falleth upon her to kill her, the hedgehog draweth itself up together, round like a football, so that nothing appeareth on her but her thorny prickles; whereat the serpent biteth in vain, for the more she laboureth to annoy the hedgehog, the more she is wounded and harmeth herself, yet notwithstanding the spite of her minde, and hate of her heart, doth not suffer to let go her hold, till one or both parties be destroyed. The hedgehog rowleth upon the serpent, piercing his skin and flesh (yea many times tearing the flesh from the bones), whereby he scapeth alive and killeth his adversary, carrying the flesh upon his spears, like an honourable banner won from his adversary in the field."

The armadillo is a snake-eater, and is said to kill his victim by contriving to get the body under his shell, and then moving backwards and forwards so that it is sawn in pieces by the sharp edges of this bony shield. In the process the victim makes frantic efforts to wound his antagonist, but the bony armour is proof against the serpent's tooth. As soon as it is slain the victor proceeds to eat the vanquished, commencing at the tail.

The glass snake is another snake-eater. This creature, by the way, is not a snake, but one of the limbless lizards found in the Balkan Peninsula, South Russia, Asia Minor and Morocco, and runs to more than a yard in length. Other species live in the Himalayas, and Burma, and North America.

Its food is, indeed, varied, though its staple diet seems to consist of snails, the shells of which are crushed, and of mice; but nothing that can be seized comes amiss, worms, insects, young birds, small lizards and vipers are all eaten with a relish. The larger victims it encircles with a lightning twist of the body, after the manner of the constricting snakes, or they are shaken, as a terrier shakes a rat, till dazed, or stunned, when they are broken up by the powerful jaws and swallowed in pieces. The heavy armature of the body, formed by the scales, makes the glass snake invulnerable to the bites of the viper, should the latter have any opportunity of making a fight for life.

Though its bite is so formidable, it is to be noted that the glass snake when caught makes no attempt to use its jaws, but instead, twists itself round one's hand and arm, besmearing them with a disgustingly stinking fluid which it discharges. Nevertheless, it is readily tamed.

It seems but just, since there are some snakes which eat lizards, that there should be some lizards which eat snakes. The eyed-lizard, common in the South of France and the Riviera, is one of these. It is a voracious animal and will attack any small lizard, slow-worm, or snake it can find. This species, by the way, attains to a length of as much as two feet and is readily tamed in captivity. The teju (*Tupinambis punctatus*) of South America, which attains a length of three feet, is another snake-eater. It is much disliked near homesteads, since it is given to robbing hen-roosts, taking both chickens and eggs. As a consequence it is hunted down by dogs, and when killed is generally eaten by the hunters, its flesh being much esteemed.

Many birds eat snakes whenever opportunity offers. And of these the most famous is the South African secretary bird, though some discount its prowess in this regard. Let us take the evidence first of Jules Verreaux. "The secretary bird," he remarks, "has been modelled on a plan appropriate to its mode of life: and it is therefore for this purpose that, owing to the length of its legs and tarsi, its piercing eye is able to discover at a long distance the prey which, in anticipation of its appearance, is stretched on the sand or amongst the grass. The elegant and majestic form of this bird becomes now even more graceful; it now brings into action all its cunning in order to surprise the snake which it is going to attack; therefore it approaches with the greatest caution. The elevation of the feathers of the neck and back of the head shows when the moment for attack has arrived. It throws itself with such force on the reptile that often the latter does not survive the first blow. But if the bird does not succeed and the enraged snake draws itself up, and expands at the same time the skin of its neck, as is the way with the more dangerous serpents, the bird is forced to retreat, and takes a spring backwards, waiting to seize a favourable moment for recommencing the attack. Raising itself, the furious reptile moves its tongue with the quickness of lightning, and gives forth the most vehement hisses, which keep back the enemy and seem to force some

W. S. Berridge

WHEN SNAKE SLAYS SNAKE: THE KING COBRA

One of the most determined destroyers of snakes is the king cobra or hamadryad of India and Southern China. It grows to a length of twelve feet, and moves with great speed. We see one here swallowing another snake, which has coiled itself in the attempt to make a loop too large to be engulfed. But the hamadryad's lower jaw is slowly forcing the coil apart.

and as soon as it arrives at the head, it completely smashes the skull by several blows of its bill before swallowing it."

Some eagles, as well as harriers, eat snakes. The serpent-eagles (*Spilornis*) of the Indian and Malayan regions are snake-eaters, as also are their near relations the buzzard-eagles (*Butastur*). Still more addicted to snake-eating are the South and Central African bateleur eagles, which attack both venomous and non-venomous species, be they large or small; the birds rapidly disabling their prey with their formidable beaks. When the grass-jungles are on fire these birds beat along the line of flame and seize the snakes and other reptiles as they creep out, sometimes dashing into the smoke for this purpose. The American swallow-tailed kite is a confirmed snake-eater, and has been seen sailing leisurely along and from time to time bending its head down to tear a piece from a small snake it held in its talons.

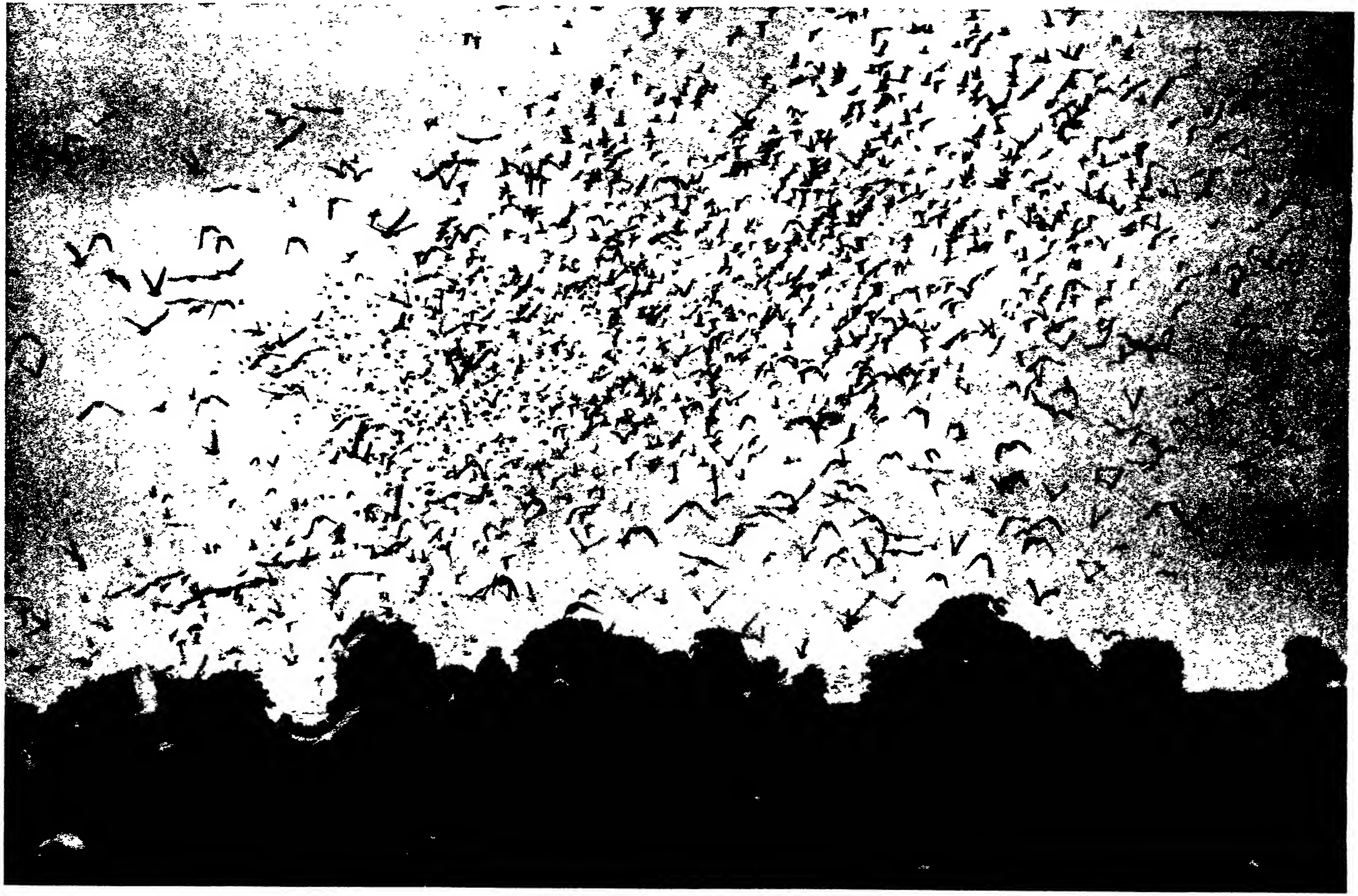
Jungle fowl and peacocks will eat snakes, though there are no records to show whether these are ever of poisonous species; and the same is true of some of the storks, including the adjutants.

respect from it: but the bird, whose courage redoubles in the same ratio as the difficulties increase, opens out its wings, and returning to the charge, assails the reptile afresh with blows from its terrible feet, such as no one would believe, and which are not long in putting the snake *hors de combat*.

"We have, however," he continues, "sometimes seen the snakes launch themselves on the secretary, but, either by opening its wings, whose long primaries serve it as a kind of shield, or by jumping backwards, or on one side, the bird is certain to parry the attack of its antagonist, who, at last, overcome by fatigue, falls at full length on the ground. The moment is seized by the secretary bird to redouble its massive blows which, by dislocating the vertebral column, soon cause the animal to give up the ghost. It is then that the victorious hawk darts like an arrow, and placing its foot upon the serpent's neck, just at the back of the head, commences to swallow it, which it does by beginning at the tail. Nor is this a long operation, even with reptiles five or six feet in length and more than four inches in diameter:

The importance of the alligator as an agent in keeping down the numbers of the deadly copper-head or mocassin snake in Florida was not realized until the numbers of the alligators became seriously diminished by the high prices offered to hunters for their hides. As their numbers decreased so the numbers of the snakes went up, furnishing us with yet another illustration of the evil effects of ignorance in disturbing the balance of Nature. It may, perhaps, be thought difficult to regard the alligator with any great increase of partiality on the grounds that it destroys poisonous snakes. Indeed, one might feel that the snakes were the lesser of two evils. Nevertheless this balance of nature is very delicately adjusted and the results of upsetting it have often gone beyond—alarmingly beyond—expectation.

Lastly, in connexion with the snakes which feed on snakes it is interesting to turn to page 140 where the bottom photograph shows us a non-venomous grass snake devouring a viper. Yet there are people who kill grass snakes on sight just because they are snakes and some snakes are poisonous.



FIFTY THOUSAND RACING PIGEONS START UPON A GREAT FLIGHT FOR HOME

Pigeon racing is founded on the amazingly powerful instinct of the birds to fly back to their homes. The sport was introduced into England in the early 'seventies and, especially in the North, has accumulated many enthusiasts. The method is to despatch the competing birds, which are specialised as either long or short distance performers, to an agreed starting place at a distance from the home of each bird commensurate with its powers. Then the competitors are released and the time is registered. At the other end of the journey each owner is waiting, and so soon as his bird arrives a rubber ring is removed from its leg and is placed in a special registering clock. The clocks are then inspected, and the bird showing the highest speed is judged the winner.

Chapter LXIII

The Homing Instinct

By H. Mortimer Batten

Author of "Habits and Characters of British Wild Animals"

THE homing instinct in Nature is one of those problems which will ever provoke a sense of wonder in mankind. Man, with his knowledge of mathematics, his instruments, his knowledge of the stars, can grope his way across seas and continents, but in the migration of birds, beasts, insects and fishes, the travel sense amounts to an inbred knowledge of direction backed by an infallible and wonderful sense of the seasons.

Without touching upon migration, however, let us take the homing instinct in its simplest forms. Here is an example. Mr. Fisher, who lived at Blairghour Farm on the shores of Loch Awe, possessed a sheep dog. This was before the days of railways in that vicinity, and during the Glasgow sheep fair Mr. Fisher took his dog with him to that city. They went by road and by boat, and the dog, a young animal, took the fancy of a Glasgow butcher, who offered so high a price for it that Mr. Fisher accepted, though he had no special desire to sell the dog. He then returned home to Loch Aweside, but to his utter surprise the dog, all by itself, arrived back from Glasgow a few days later.

Now, a glance at the map will show what this meant. For the dog to return by the way it was taken would have been impossible ; it must have returned by land, which meant an enormous circuit of the west coast lochs, through country over which it had never previously travelled. It must have covered a distance of well over sixty miles, going far north of its destination, then turning south to gain its home. Thus the dog's homing sense did not merely lie in covering a straight line from point to point ; it meant far more—the direction of home after it had exceeded the distance in a northerly direction, and was compelled to travel back.

OF all wild creatures of Britain, the homing instinct is probably more strongly developed in the red deer than in any other. The red deer have a great love for their own native ranges—for the land in which they were born, and where their mothers nursed them. A stag in his later life may cross ranges and rivers, but always, when no other instinct calls, he returns to his native land. Much the same applies to hill sheep. I have known a horned ewe to cross two ranges in order to regain her native hills from which she had been sold.

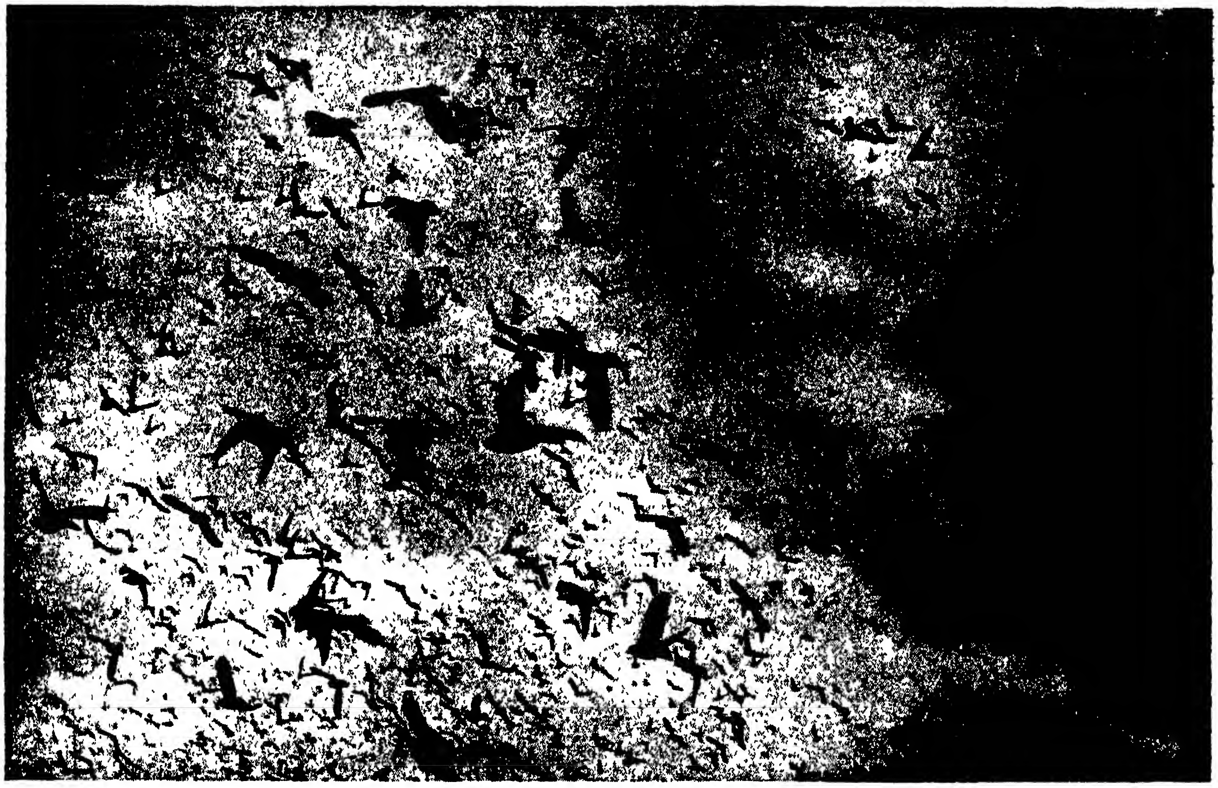
Sometimes, to improve the blood, deer are exported to distant lands, or maybe from the mainland to some outlying island. The stag is pounded and probably netted out, and amidst the general turmoil, his horns are sawn off. He is shut in a crate, from which he can see nothing, and the crate is eventually loaded aboard a motor van, which, by intricate hill roads, finds its way to the loch steamer. It is taken aboard the steamer, probably by means of a hoist, steadily revolving till it reaches the deck, and the boat gropes her way out by the tortuous routes of the sea. Thus the stag is taken to some new locality and liberated, but a week or so later he is observed back on his native range. Scottish stags exported to New Zealand have been found far out at sea, swimming faithfully towards the North—heading, oblivious of certain death, across the width of the world for their native Scottish hills !

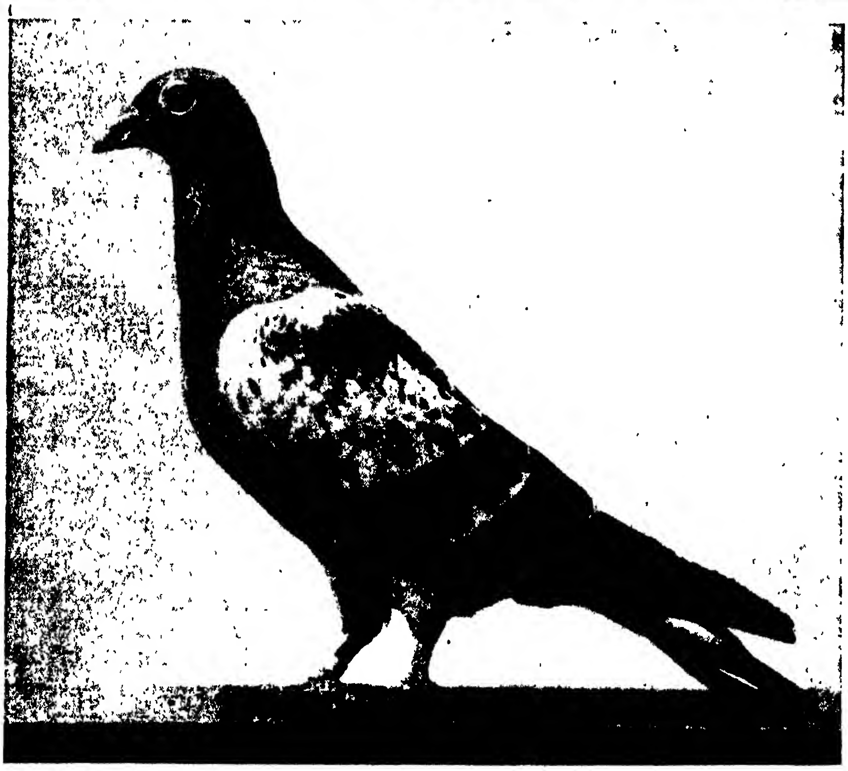
WHEN I was a youngster I was well acquainted with a pet roe-deer. When he was small he was a delightful little companion, and dearly loved his little mistress. No child could have had a daintier or more attractive pet, but as he grew older he resented any trespass upon his little mistress's companionship, and his budding horns were becoming dangerous weapons. During his life he had never so far ventured beyond the gardens and policies of his home, where his needs and amusements were met, but on his becoming mischievous, it was decided that he must be returned to his own wild race among the mountains. He was, therefore, trussed and boxed up in a laundry hamper, which was carried across the ranges in a ramshackle old motor-car, then by boat across a loch to a keeper's lodge on the other side of the range. Here he was handed over to the keeper who was in charge of the outlying beat, it being thought that the man might wean him gently from the ways of domesticity until he was ready and glad to gravitate back to his own kind once more.

At the keeper's lodge the laundry basket was opened, at which the little buck, red-eyed and indignant, bounded out. In the twinkling of an eye he had scattered the spectators, then over the wall he went, and into the birch woods. That evening, within an hour of the motor-car arriving back, the roebuck's little mistress heard the familiar tapping of his hoofs on the door of the summer house, where she was accustomed to do her lessons.

A friend in Edinburgh tells me that in the days of his boyhood the family had a much beloved retriever attached to their summer residence at Gartincaber, and during the summer they became so fond of him that it was decided to take him home to Edinburgh for the winter months. The journey was made by road, but the old dog was shut up in the rumble of the equipage, from which he could see nothing, and was probably not too liberally supplied with air. Thus he was conveyed across Scotland, but no sooner was he liberated in Edinburgh than he fled in panic. Late the following day he was back at his native kennels at Gartincaber.

Of course, a multitude of questions arise Probably the first conclusion to which we come is that in these





HOMING PIGEONS IN FLIGHT FROM HITCHIN TO THE NORTH

Here is part of a great flight of over forty-six thousand pigeons which are engaged in a race from Hitchin, Hertfordshire, to their homes in the North of England. The birds, packed in some two thousand baskets, arrived in two special trains from South Shields and Newcastle, picking up competitors as they went. The lower photograph shows a racing pigeon.

cases a dog backtracks by scent. This may be possible on occasions, but not always. There are many cases which disprove it, such as the case of the dog which found its way back to Loch Awe. Here is another. A gentleman I know lived about eighteen miles from Paris. He went to Paris by train each day, crossing the city from east to west Sometimes he took his little spaniel with him, and one day, when he had left the dog at home, he was surprised in the late forenoon to find that young gentleman ushered in by a clerk. The little dog greeted his master with delight, but the mystery remained. How did the animal find his way across country and across the city of Paris to the offices ?

The matter did not end there, however, for a few days later the door of the office was again opened, and this time not only the spaniel frisked in, but also a bulldog and a Dalmatian hound, dogs

J. J. Ward

RAT RETURNING TO ITS HOLE AFTER A PROWL ROUND THE GARDEN

However far it may roam in its nightly, and sometimes, daily wanderings in search of food, the rat has one home and returns to it until circumstances force it unwillingly to seek a new abode. In the upper photograph a common brown rat is prowling about the garden and is examining the rock border which separates a path from the flower bed. Below we see it beside the hole it has dug for its home, unheedful of the unquestionable publicity of such a site, right in the middle of the garden path.

J. J. Ward

POSSESSING A STRONGLY DEVELOPED HOMING INSTINCT: THE HEDGEHOG

In the thickest part of a hedge or in some dense undergrowth the hedgehog makes its home and spends the day-time there rolled up and asleep. When night comes the little mammal wakes up and goes out to seek its food, which may be anything from an adder to a plant root. If kept in a semi-tame condition in a garden the hedgehog is a useful destroyer of slugs and, indeed, except to those who preserve game, the animal is entirely harmless despite old countrymen's prejudices to the contrary. At dawn the hedgehog goes home.

to the stables of my friend's establishment, and which had never previously visited the city.

In the far north-west some marvellous stories are told of the homing instinct in dogs of the husky and malemute breeds, but many of these accounts are difficult to prove. I remember one touching case, however. A prospector died away up-country, about three hundred miles from Nome City, and was lowered into the ice by his companions. His favourite malemute would not reconcile himself to any other master, but when the ice broke four months later he boarded the river steamer with a throng of adventurers and went to Nome, which the dog had often visited with his master. There for several weeks this great husky brute searched the drinking dens and the billiard parlours, meeting every canoe which came in from the creeks till he became quite a well-known figure. What became of the dog eventually I do not know.

The homing instinct in dogs is little more than we might expect in view of their devotion and intelligence, and parallel examples would be hard to find among the rank and file of our other fireside pet, the cat Still, cats are not lacking in this wonderful respect, as is proved by the following example coming within my own personal experience.

One day a picnic was arranged for a party of children, and one child wished to take her kitten with her. The kitten was packed into the usual double topped hamper, and the party went by car, crossing the river by the one and only bridge for several miles, then through the birch woods on the south side of the loch. The picnic was held about seven miles from home, so that between that place and the point at which the kitten was liberated there extended a rapidly flowing mountain river, which emptied itself into a loch several miles in length. The only way back, then, was across the bridge, and having regard to the roughness and the wildness of the country, one would hardly expect a small animal like a kitten to be able to find it.

Well, the kitten was liberated from the basket, and enjoyed the picnic as much as anyone, but when it came to returning home, no kitten could be found. The search extended till dusk, and in the end a very forlorn party was compelled to abandon the hunt. The following morning the kitten arrived home—wet and bedraggled and hungry and wretched, but nevertheless glad to get back.

H. Mortimer Batten

DEER THAT WILL FACE GREAT ODDS TO REGAIN ITS NATIVE HEATHS

Of all wild animals the deer seems to have the homing instinct most strongly developed. Often in Scotland red deer are removed from one district to another for the purpose of improving some local stock. A stag may, when captured, be driven many miles in a motor lorry, taken across a loch in a steamer, and perhaps eventually landed on an island. Yet, in a week or so, the animal will be back again on its old range. Scottish deer taken to New Zealand have been found at sea, swimming steadily in the direction of home.

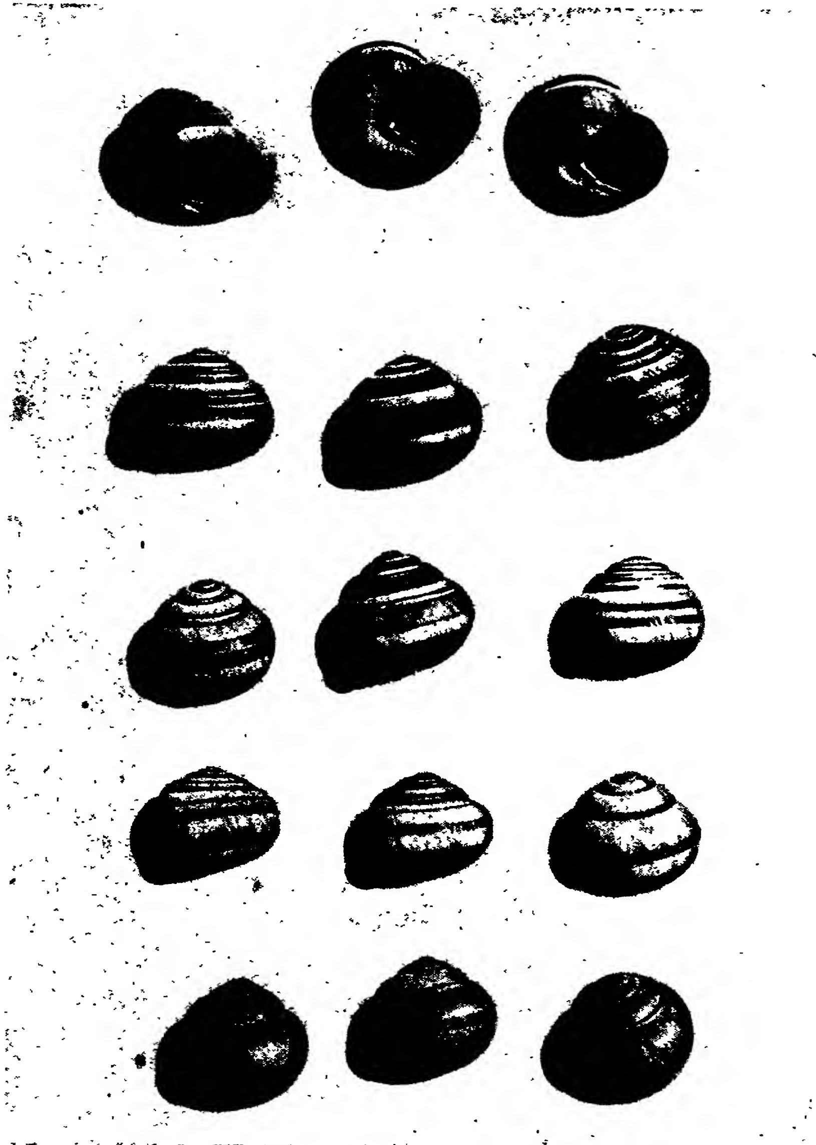
While certain breeds of pigeons are famous for their homing instinct, their "bump of locality" being abnormally developed, and while this faculty has been increased by breeding for long-distance flight, there can be no doubt that many wild birds are more remarkable than the pigeon in this respect.

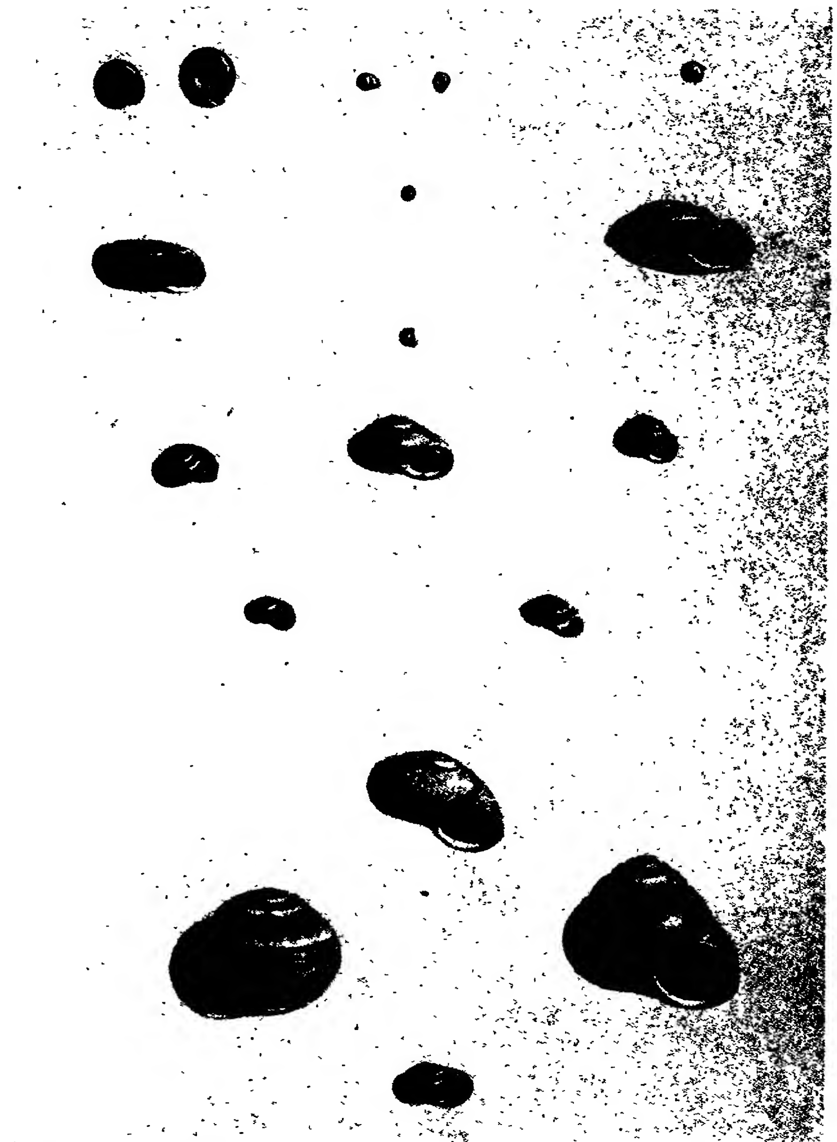
It would seem that in the brains of most animals there exists a little compass point bearing infallibly upon the region they love. Distance cannot rob it of its magnetic pull; they may have to turn and yet turn back, but the compass point does not fail. A single error might throw them miles out of their reckoning, but the error simply does not occur. A sense of direction, and that only, is the guiding power. It cannot be scent or memory of landmarks—that is manifestly disproven, and man can, to some extent, acquire the same instinct.

At one time of my life, when for weeks and months on end we travelled by maps and by compass, I found myself acquiring a sense of direction unknown in the ordinary course of life. I acquired the habit at night-time of pointing out the north, and often it was difficult to decide which was the north until one closed one's eyes; then opening the flap of the sleeping-bag, one could check the direction by the familiar glare in the heavens. Thus acquired, this sense of direction has never left me, and in the Underground Railways I can pick out the north.

Take a Red Indian, blindfold him, turn him round half a dozen times, then give him a few seconds to collect himself, and he will lay his fingers on the points of the compass. I have known Indians to travel incredible distances over country they had never previously traversed, sometimes through dense undergrowth where no landmark was visible, yet eventually striking a certain point without a single readjustment of their bearings.

What a savage can learn a white man can acquire if it is worth his while, and there is no doubt that the homing instinct in animals has, up to a point, its counterpart in human beings. In our artificial lives we have lost many gifts and senses, since they are no longer of use to us, and thus the homing instinct in animals is a far greater wonder to us than it is to less civilised people. In civilized man the homing instinct, if he has one, seems to have become rather a sentimental attraction for the place where he grew up and spent his youth, than a definite idea of how to get there in terms of direction.





E. Step

EXTRAORDINARY VARIETY BOTH IN SIZE AND MARKINGS AMONG THE BRITISH SNAILS

In the left-hand photograph we have a number of examples of one of the most commonly seen British snails, Helix nemoralis. The shell is ornamented with a series of chocolate-coloured bands, and the variety of the arrangement of these bands is extraordinary among individuals. The ground colour may be almost white, dark brown, flesh-pink, or even bright yellow. This snail should be looked for in hedges and can otherwise be found in very many gardens. It is, with the exception of its near relative, Helix hortensis, the most brightly tinted and variously marked of all British snails. Birds of all kinds, from chickens to thrushes, are very fond of it. The right-hand photograph shows some remarkable variations in size among some of the other land snails.

Chapter LXIV

The Strange Story of Slugs and Snails

By Wilfred Mark Webb

Author of "The Eton Nature Study Note Book"

In the garden are things with legs—spiders with eight, centipedes with many—insects with wings, and worms which wriggle, but in the current language of the advertisement writer, the snail is the creature "which is different."

In the first place, like the slug, whose name proclaims its habit, the snail moves sedately with the help of the whole underside of its body, which adheres to the ground. Its eyes have not only started out of its head, but are on the tips of sensitive tentacles which can be pushed out some distance in advance of it. The snail differs, however, from its relative in that its large coiled shell prevents us from thinking of the division of its body, by an imaginary line, into two similar halves.

To see how such animals really do get from place to place a piece of glass is necessary, and when a snail, for instance, has started to crawl on one side of this, it can be turned over. Then a remarkable series of ripples, due to the expansions and contractions in the muscular underside of the creature, which is called "the foot," are very evident and result in the front end being slowly pushed forward and the hind pulled after it.

Shells have had an attraction for human beings from the times of the cave men onwards, and are worthy of some detailed study. The spiral ones can be mathematically described as a coiled hollow cone, and, like screws, may be right or left-handed. Those of the common snail and the majority of univalves, both in the sea and on the land, belong to the first category, and when the tip of the shell is pointing away from the onlooker its mouth is on the right side. Left-handed shells, with the spiral reversed, occur as rarities in right-handed species, but there is a number of snails in which they are the rule instead of the exception and a few in which one form of twist is as common as the other.

The making of a shell is much like the building of a concrete wall. There are three layers, the outermost thin, consisting mostly of animal matter and secreted by the edge of the bag or "mantle" which lines the shell. This horny layer gives the fresh appearance to the shell and during its construction corresponds to one set of boards used for wall-making, while the surface of the mantle makes the other, and the edge again pours out a mass of limy matter into the space, just as the builder would put in his mixture of stones and cement. This calcareous secretion crystallises and forms the second layer, to which a third, similar to the mother-of-pearl in an oyster, is added by the surface of the mantle.

In the sea and in fresh water many of the snail's relatives, like the periwinkle, can shut up their houses, when they retire into them, with a shelly lid permanently attached to the end of the body. A few amphibious forms, and others that have come to live on land more recently than our more familiar species, still possess one. Some among the true snails make a temporary lid in summer to keep themselves from being dried up and in the winter as a protection against the cold or living enemies which cannot manage to break their shells.

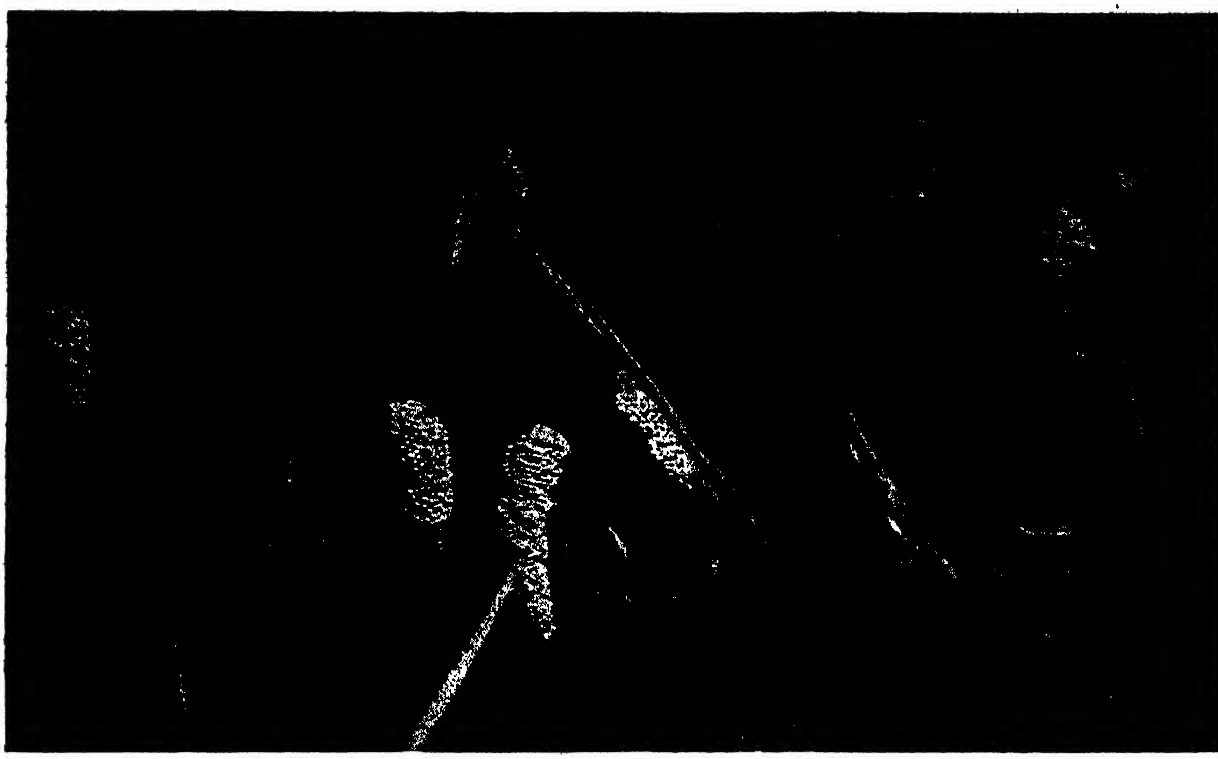
Quite substantial structures may be produced as in the case of the so-called Roman snail which uses much lime. This hardens into a smooth white temporary lid, which is thrown away when the spring comes. All sorts of devices have been developed to keep out other carnivorous snails or the grubs of beetles, such as those of the glow-worm, and of other insects.

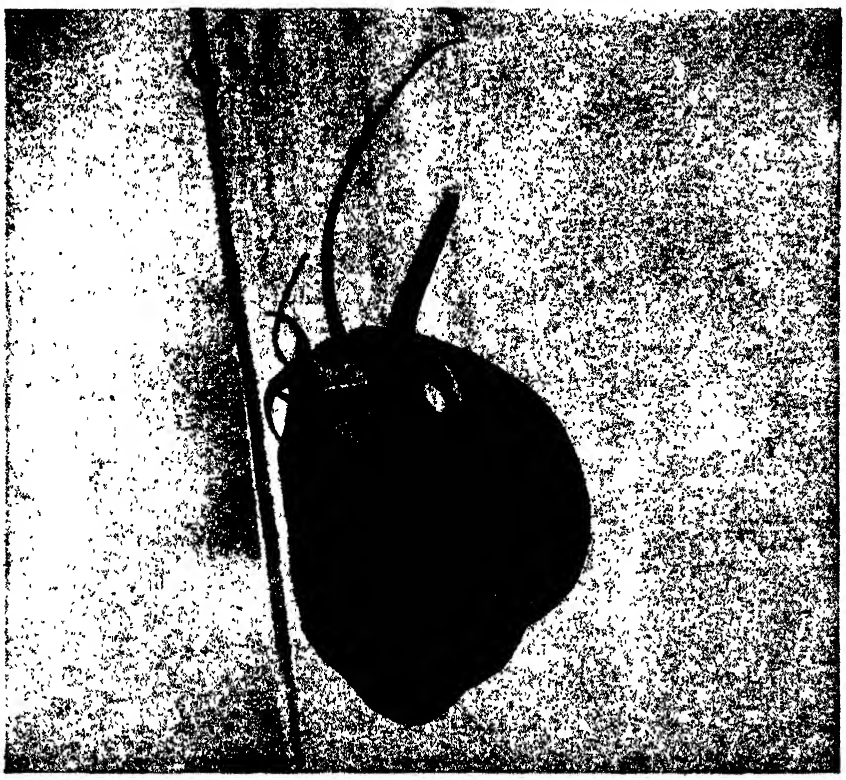
The mouths of some shells are made more narrow if the creature lives to become adult, and this in desert snails would also tend to prevent undue evaporation. Pleats and prominences called "teeth" serve commonly to protect the entrance and at times a deep dent on the outside of the shell a little distance behind the opening marks the spot where an extra large internal projection partially blocks the passage

A further development is found in the high-spired left-handed forms which I have called swing-door snails. Here, in addition to folds in the shell, is an additional safeguard in the form of a curved plate of the same material as the shell hinged to it, which serves to block the entrance when no portion of the animal is outside the shell. This can be seen in position by cutting away a piece of the shell, or a picture of it can be obtained by means of the X-rays.

We may turn again now to the animal. The horns or tentacles have already been mentioned, and of these there are usually four, though in some of the tiniest snails only the upper pair are developed which bear the eyes. These are very easily and quickly put out of harm's way, for their supports are hollow and have a special muscle running up to the top inside. The slightest touch causes the muscle to contract and the eye is pulled into the head in the same way as a glove finger is turned outside in. On the other hand the eye is extended by the contraction of the walls of the tentacles which turn it right side out again. A few species, including the needle snail of Britain, which live underground in the dark, have become blind.

The mode of feeding in snails and ordinary slugs is uncommon to say the least of it. When the mouth is applied, for instance, to a cabbage leaf, as it often is, the animal gets a purchase upon it by applying to the surface a horny-looking "upper jaw" with ribs on it which prevent it from slipping Then a muscular lever standing up from the floor





F. W. Bond

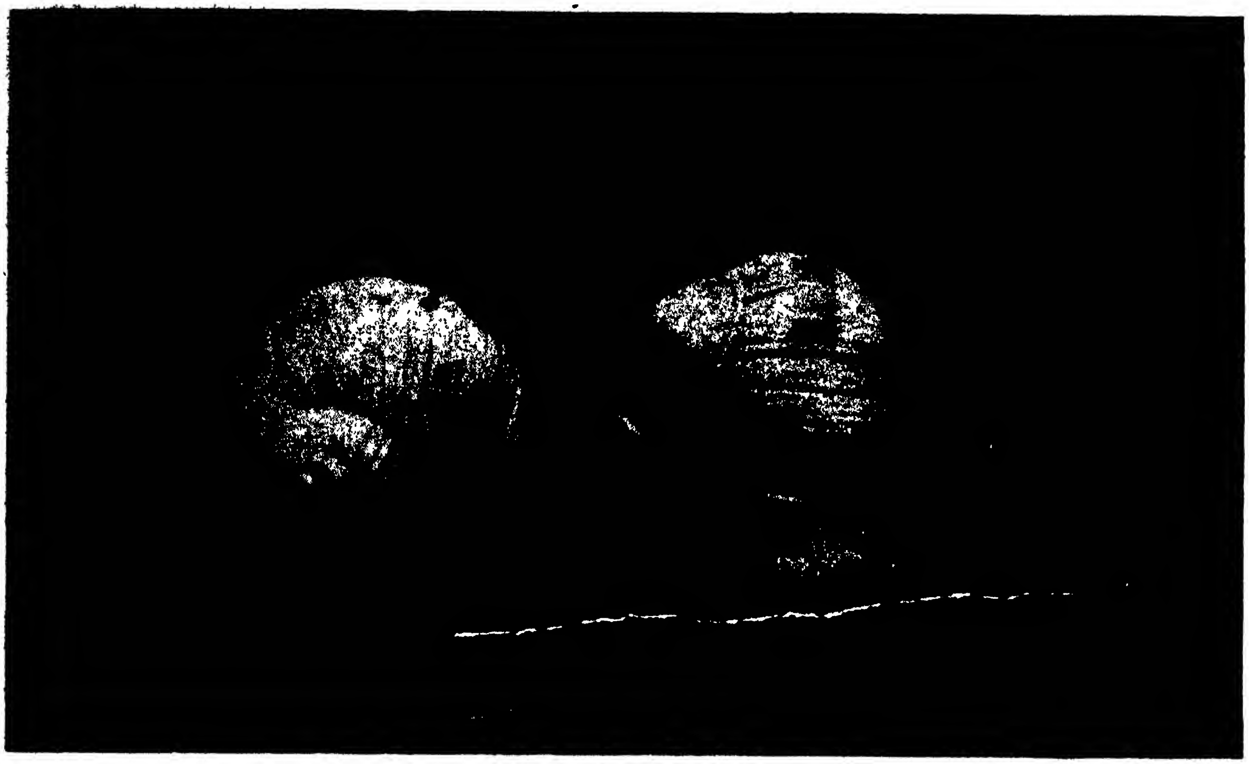
AMPHIBIOUS APPLE SNAIL AND ITS EGGS

South and Central America are the homes of the amphibious or apple snail, which has a remarkable breathing apparatus enabling it to live as well in water as on land. The long tube used under water is seen extended in the lower photograph. Above are the clusters of eggs this snail lays on water plants. At a distance they rather resemble grubs crawling on the leaves.

of the mouth brings into action a band-shaped flexible rasp disposed over the front and top of the muscle and running up the back from a little bag, in which more of it is being formed and furnished with new "teeth" to take the place of those which are worn out in front. The forward movement of the lever brings the natural rasp through the open mouth into contact with and along the leaf. Portions of the latter are thus effectively removed in a finely divided state ready for digestion, and carried upwards and pushed towards the creature's gullet by the backward stroke of the muscle.

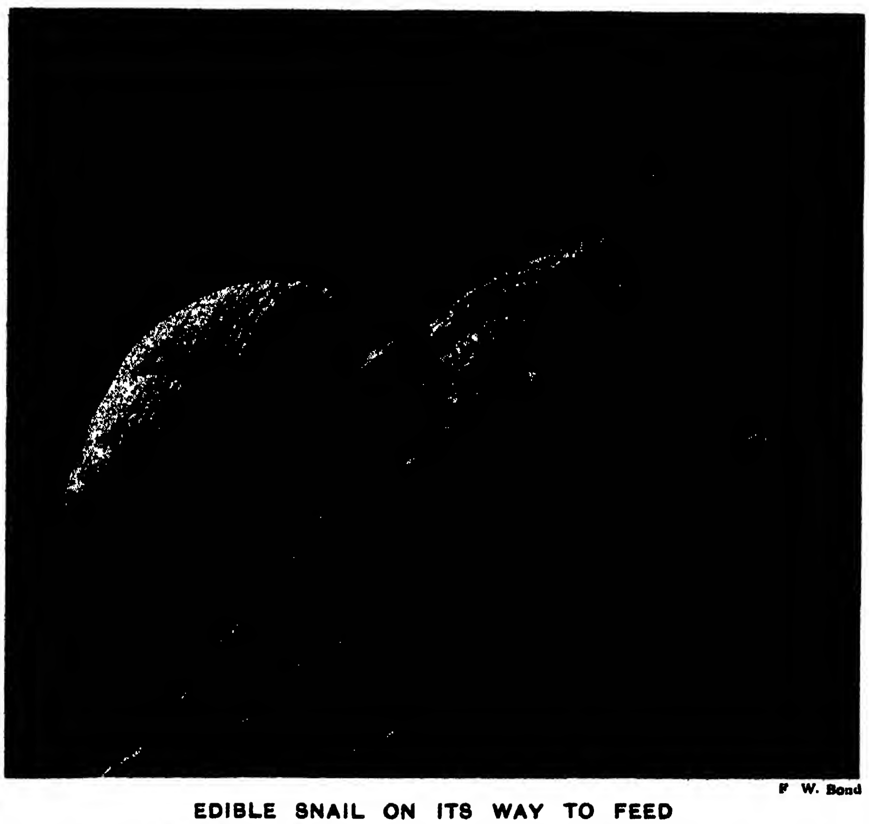
The carnivorous slugs have the same apparatus, but it and they have—as we shall see—been greatly modified in connexion with the capture of their prey and their peculiar underground life.

The breathing of a snail or slug is curiously comparable to the airing of a room by throwing open the window. If one of the animals is watched when crawling, a large opening in the



right side of its body will be seen or will after a time make its appearance. This corresponds to the window. In the snail it is under the edge of the shell and best seen from the underside when the animal is crawling on glass. In most slugs it is near the margin of the shield, in various positions in different genera. In English kinds it is in the front in the great arions of the field paths and their smaller and destructive representatives in the garden whose name begins with A. In geomalacus, the spotted Kerry slug which Ireland shares with Spain and Portugal, it is farther back. When we come to Limax, to which most of our species, the great grey, the yellow, and the field slug belong, the breathing orifice is behind the middle of the shield, and the "T" of testacella, the worm-eating slug, serves to remind us that the opening is not far in front of the tail.

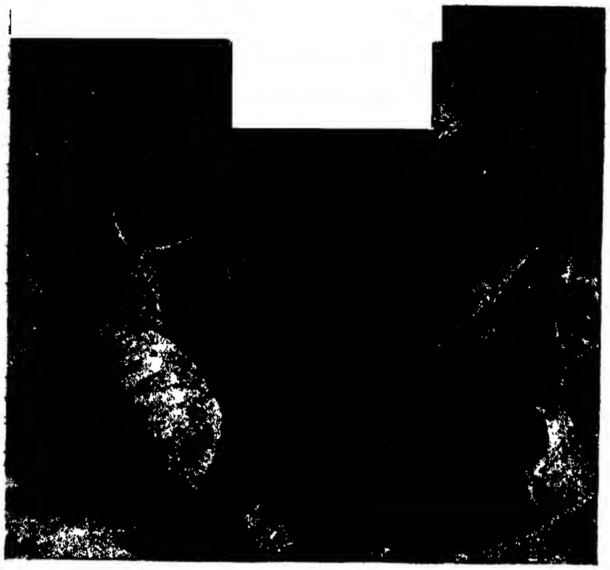
In all cases it leads into the lung chamber (corresponding to the room), whose sides are



F. W. Bond

EDIBLE SNAIL ON ITS WAY TO FEED

While all British snails are probably quite edible—and a snail is presumably no less so than a winkle—only the largest is called the edible snail. Its official title is Helix pomatia, the second word being derived from the Greek and alluding to the lid with which this snail closes its shell. It is said that it was introduced into Britain by Roman soldiers, but this is very doubtful.



Garden snails feeding on rhubarb leaves

Garden snail with shell which it has mended J. J. Ward

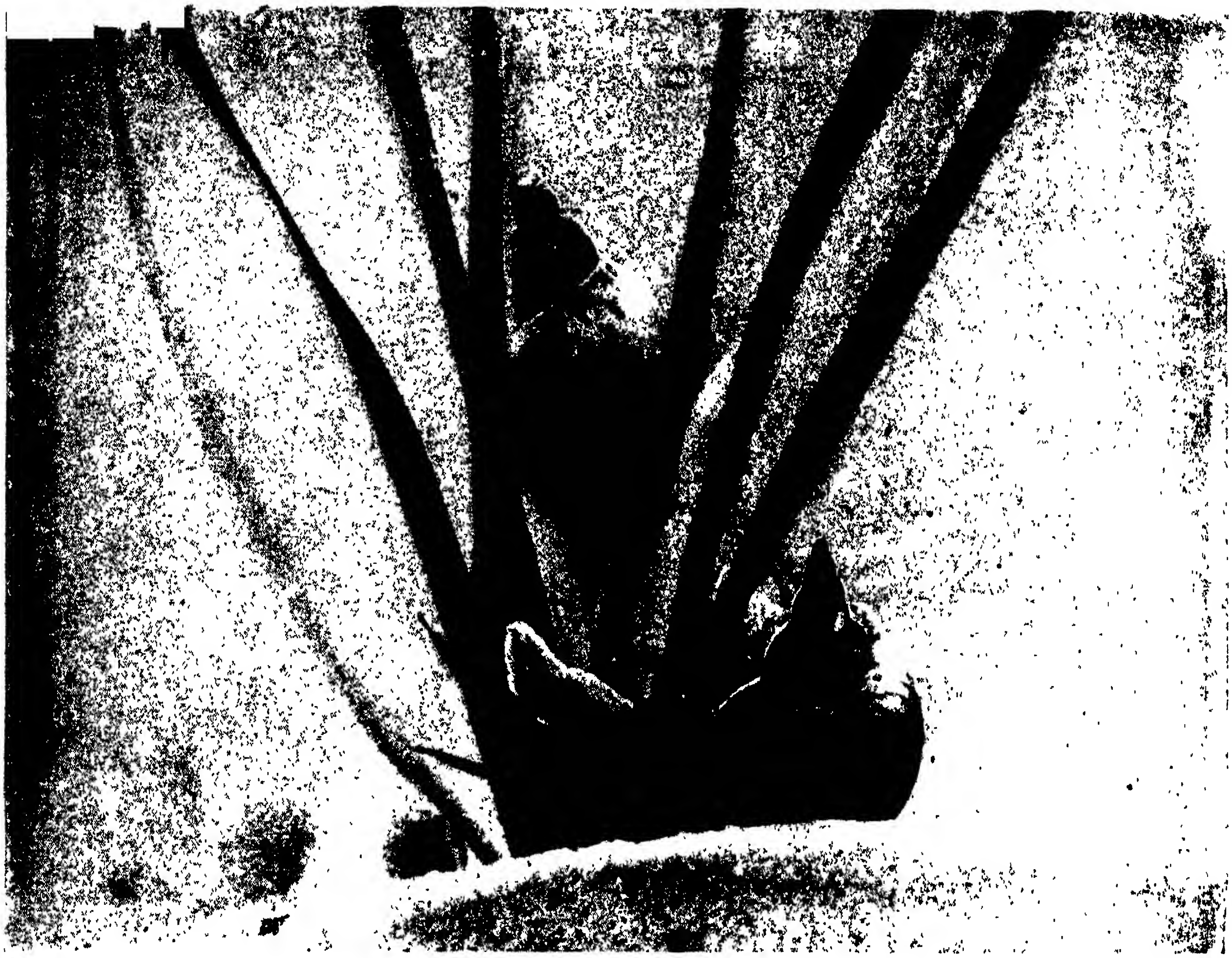
Garden snail with its eggs

Garden snail travelling over a glass edge M. H. Crawford

Lapidary snails on a rock

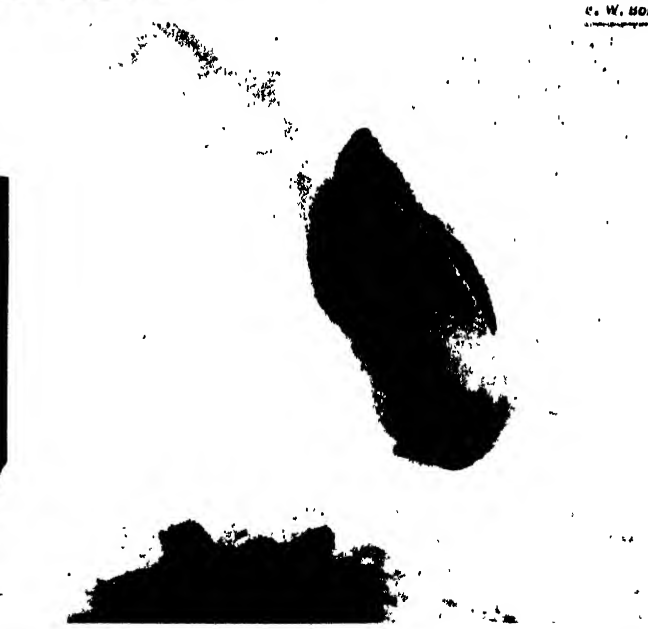
EVERYDAY ACTIONS IN THE SNAIL'S SLOW-MOVING LIFE

One of the most remarkable things to be noticed about a snail is its method of eating. When the jaws are opened a wonderfully fashioned tongue, rather like a rasp, comes into play. The top left-hand photograph shows Helix hortensis, which is not so often seen in gardens as its name suggests, feeding on a rhubarb leaf. The snail goes to work with a side-to-side movement of the head and the rasp-like tongue cuts the leaf into fine pieces. Another photograph (centre right) shows a snail on a glass plate and the action of the "foot" in moving.



C. W. Bond

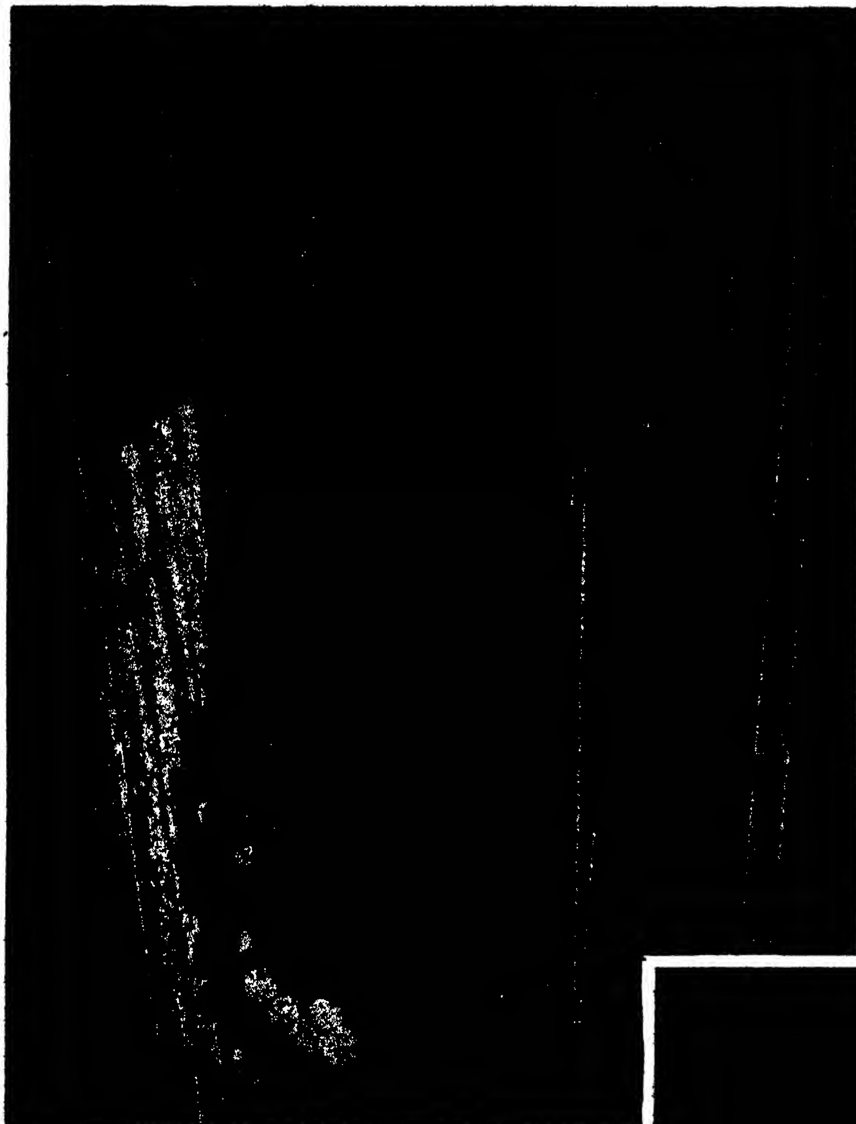
J. C. Johnson



J. J. Ward

POND SNAILS AMONG THE WATER-WEEDS THAT ARE THEIR HOMES

Nearly all snails lay eggs, and here is a clutch of water-snail's eggs (bottom left) adhering to the leaves of a water-plant. Like the eggs of the apple snail in page 686, it will be noticed that these look like some grub or caterpillar when seen in a mass. The water-snail in the bottom right-hand photograph looks, from this angle, like some strange new animal. Of the British snails 46 out of the 127 species live in water. The upper illustration shows one of the more common ones, Limnaea stagnalis, which is the largest of its family.



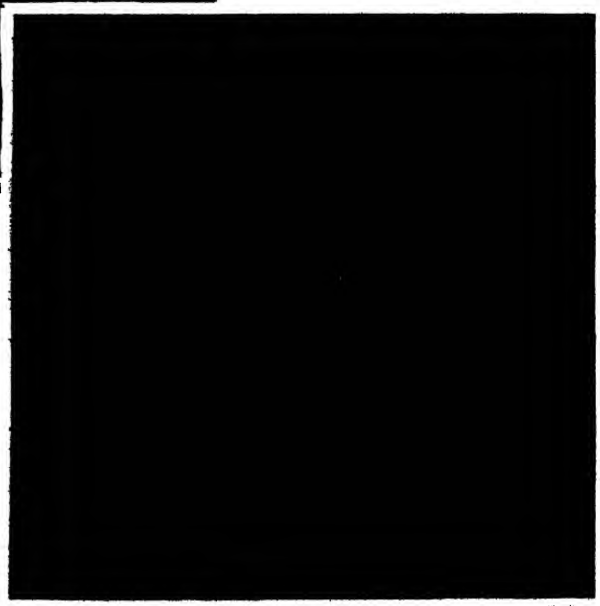
F. W. Bond

plentifully supplied with blood vessels connected with the heart, and through their walls oxygen is taken in and carbonic acid gas given out. When the air in the chamber contains too great a proportion of the latter the orifice opens and by diffusion the normal proportion of the gases in the chamber is regained.

Not the least strange feature of the creatures with which we are dealing is the fact that they, like many plants, have the functions of both male and female sexes carried out by the same individual and at the same time. In these hermaphrodites pairing duly takes place and eggs of each animal may be fertilised by the sperm-cells of the other.

Snails are proverbially slow and if a specially placid one, dwelling in the garden or hedgerow, is unresponsive to a would-be lover and returns not the proffered caress, the suitor does not need the kind help of Cupid, for Dame Nature has given to the snail a love dart of its own. This is a sharp calcareous weapon, often delicately chiselled or of elegant shape, carefully kept in an inside sheath or pocket, and it is by the turning of this inside out that the point is bared for action. This process might result in the dart becoming detached, and certainly one has been found sticking in a leaf which it had pierced; but it seems that the suggestion that the dart is actually shot at a venture through the air is a flight of poetic fancy and that the spicule usually remains attached to the owner as no aim could be taken. At the same time it is wonderful enough in itself, albeit it is customarily used more in the fashion of a dagger and in reality acts as a spur. In higher animals in which the sexes are distinct the female only in rare instances does the courting, and therefore it is all the more interesting to note that the love dart of the snail belongs to its feminine side.

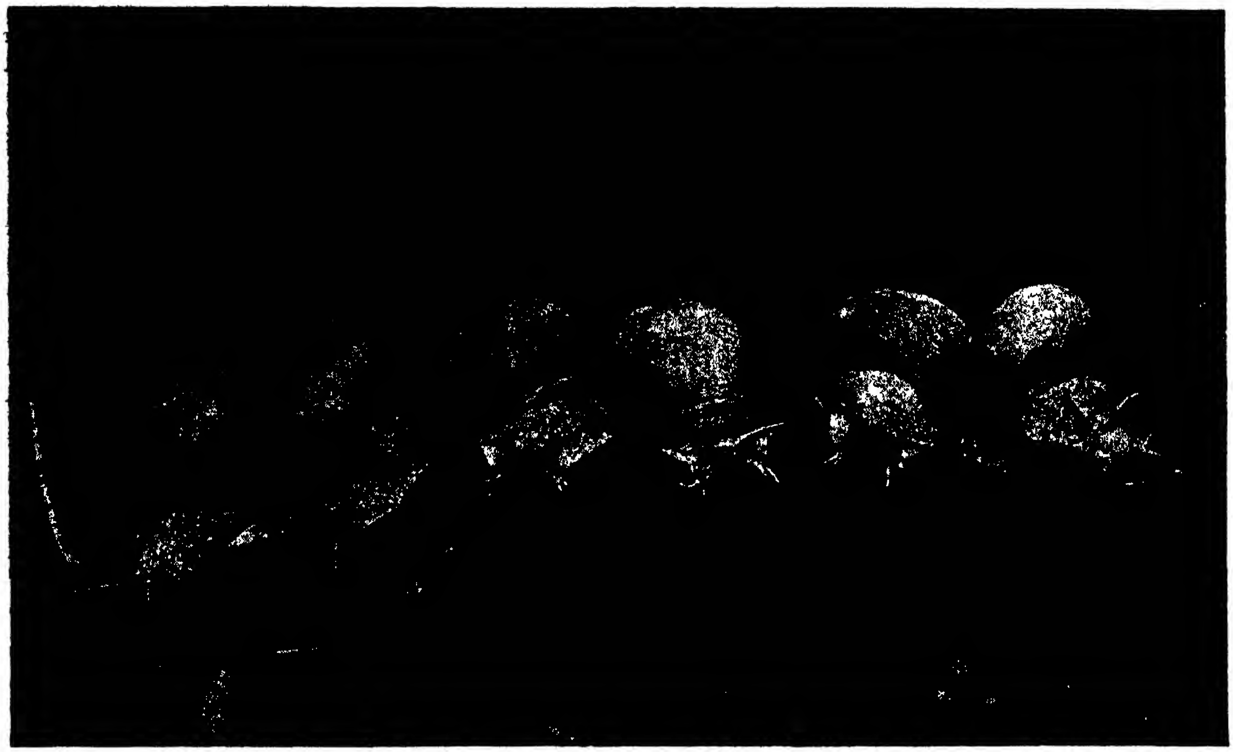
Nearly all slugs and snails lay eggs, and those which are most likely to be seen in



E. Step

GARDEN SNAIL AND AN APPLE SNAIL'S EGGS

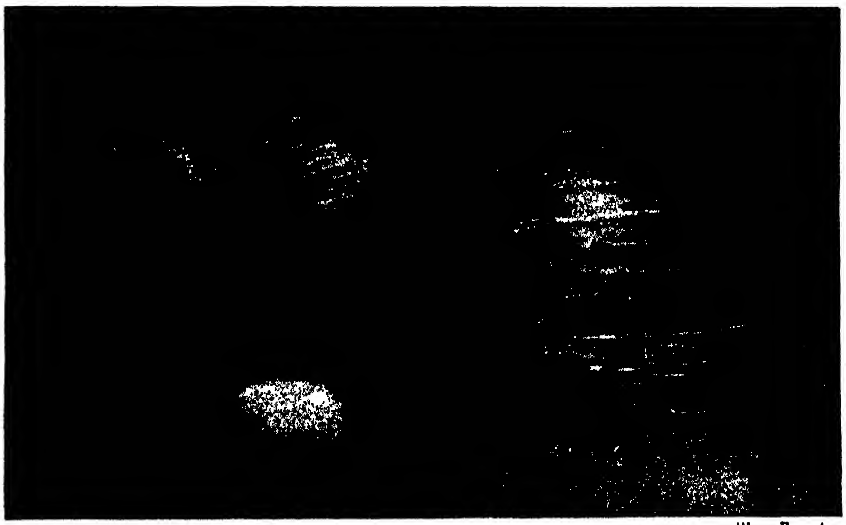
Most snails live from between two to five years. In hot weather they [illegible]
shall [illegible]
Below is a garden snail and above apple snail's eggs



F. W. Bond

England are the semi-transparent ones of the ordinary vegetarian slugs which may often be found lying on the ground under damp matted grass looking like a heap of small pearls without any of their fine lustre.

In the coverings is little or no lime, but in the case of snails this is present, so that they can rightly be called egg-shells. The giant forms of the West Indies and South America produce eggs which might easily be mistaken for birds' eggs. The most familiar kind are as long, if not as broad, as sparrows' eggs, with a pure white matt surface, but there are bigger ones laid by larger species in the last-mentioned place and South Africa which are highly polished and therefore more liable to take people in, and there is one in the shell gallery of the British Museum at South Kensington which is one and three quarter inches long and rivals a pigeon's egg in size.



W. S. Berridge

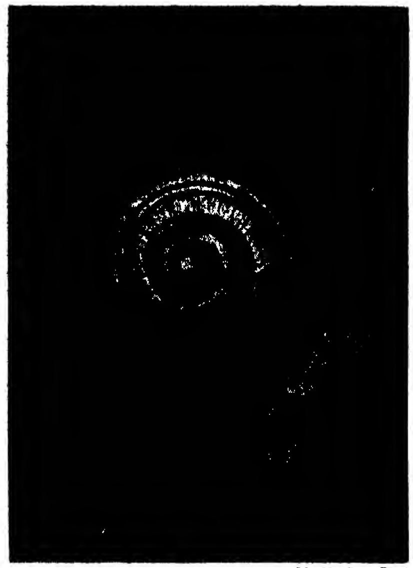
GIANT SNAIL AND ITS EGG: BRAZILIAN LAND SNAILS

The giant snails of the West Indies and South America lay eggs as long, if not as broad, as those of a sparrow. The shells contain lime and closely resemble birds' eggs in appearance, having a pure white matt surface. Here (bottom) is one of these giant snails with an egg, while the upper photograph shows some specimens of Brazilian land snails.

Some of the swing-door snails hatch their eggs inside their shells, and the fact that the so-called fresh-water whelk does the same thing is indicated by its Latin name of *vivipara*.

The snails belong to various families, and slugs without an external shell are to be found in more than one of these. They gain advantage over the larger snails, for they can creep into narrow crevices out of the way of feathered and other enemies where it would be impossible to drag any but the most minute kind of shell.

The main bodily difference is that most of the viscera, instead of being in a bag which forms a coiled



M. H. Crawford

HOW SNAILS OVERCOME THE PLANT'S PROTECTIVE MEASURES

Plants have evolved a number of means by which to protect themselves from the attacks of various enemies, of whom the snails are among the most formidable. The snails, on the other hand, have taken counter-measures, as we see from the above photographs. On the left is a snail climbing the armed stem of a briar by covering the harmful surface with slime. When resting (centre) it hangs by the same slime. It can cope equally well with a thistle leaf, as the right-hand photograph shows.

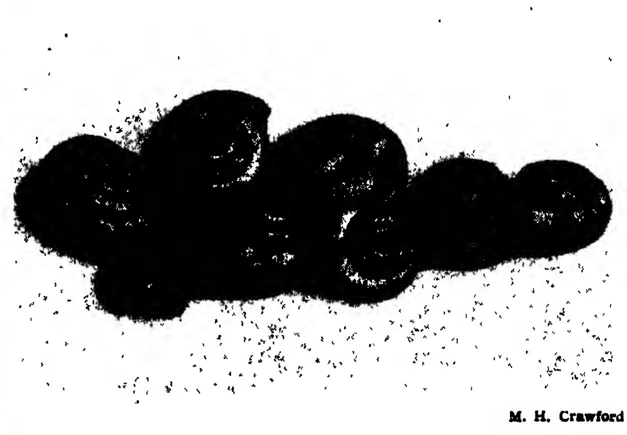
hump on the back of a snail, is in the hinder end of a slug, and the bag is reduced to a shield, under the front of which the head can be pulled and which in some cases is strengthened by an internal shelly plate. In others, where the skin is extraordinarily tough and unpalatable, as in the black slugs we see openly crawling about after rain, the shell may be reduced to a few limy granules, for these creatures are not often attacked by birds and their vitals need not be specially protected from a peck.

The worm-eating slugs, as we have already pointed out, differ so markedly from the usual run of slugs that they are worthy of special description. They usually have a small ear-shaped outside shell, and this is nearly at the hinder end of the animal. Most of the nternal organs consequently lie in the part of the body which in the snail we should call the neck.

The worm-eating slugs burrow under ground and crawl along worm holes. The small shell would in such places protect them from an attack from behind. These remarkable creatures are able to elongate their bodies in a way that recalls a cat, and can proceed along a narrow tunnel. On the other hand they may hunch themselves up and become short and thick.

Perhaps the strangest thing about them is the immense development of the muscle in the mouth,

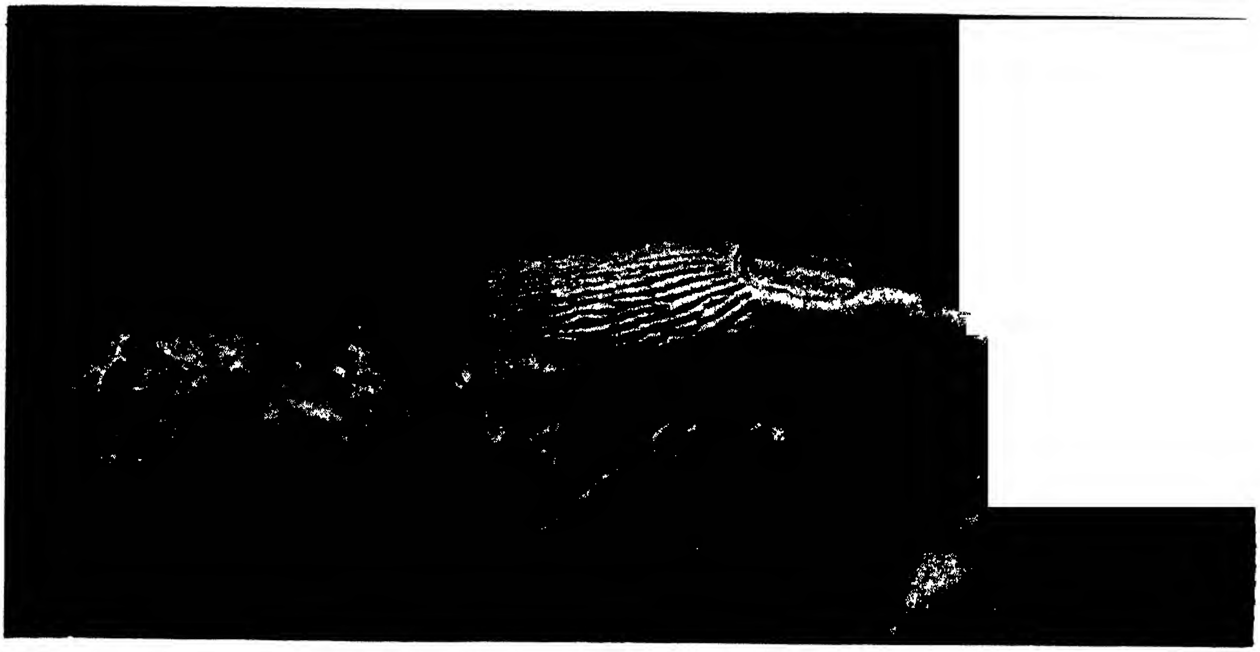
J. C. Johnson



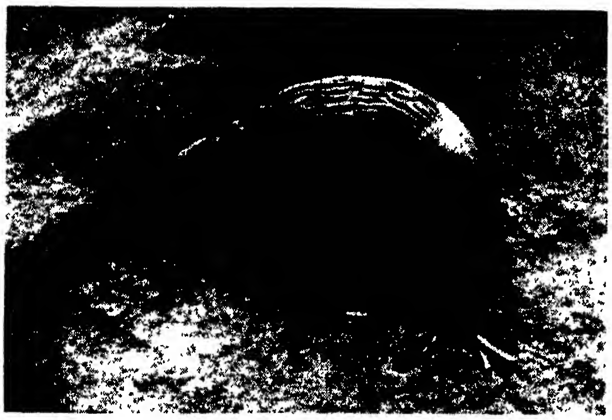
M. H. Crawford

SNAILS SLEEPING THROUGH THE WINTER IN THEIR SHELL HOUSES

Carrying their homes about with them wherever they go, the snails have only to find some damp spot where they can be inconspicuous and there take up winter quarters. Lack of moisture is all they fear, otherwise life is very simplified compared with the lot of many other creatures. Some snails have a lid or operculum with which to close the entrance to their shells, while others effect the same purpose with a layer of slime The right-hand photograph shows a group of eight specimens of Helix pisana.

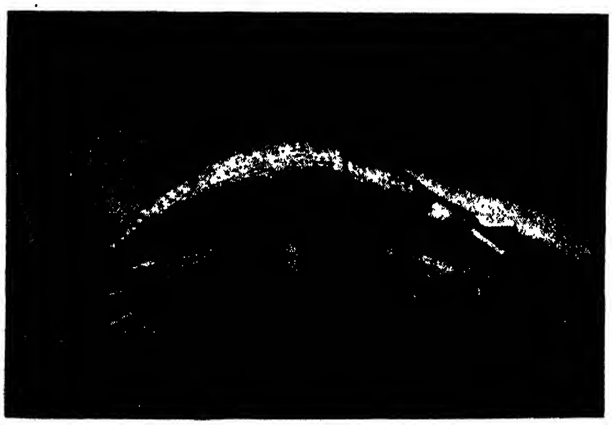


Red slug crawling over the ground



Common black slug

Black slug with body partly extended

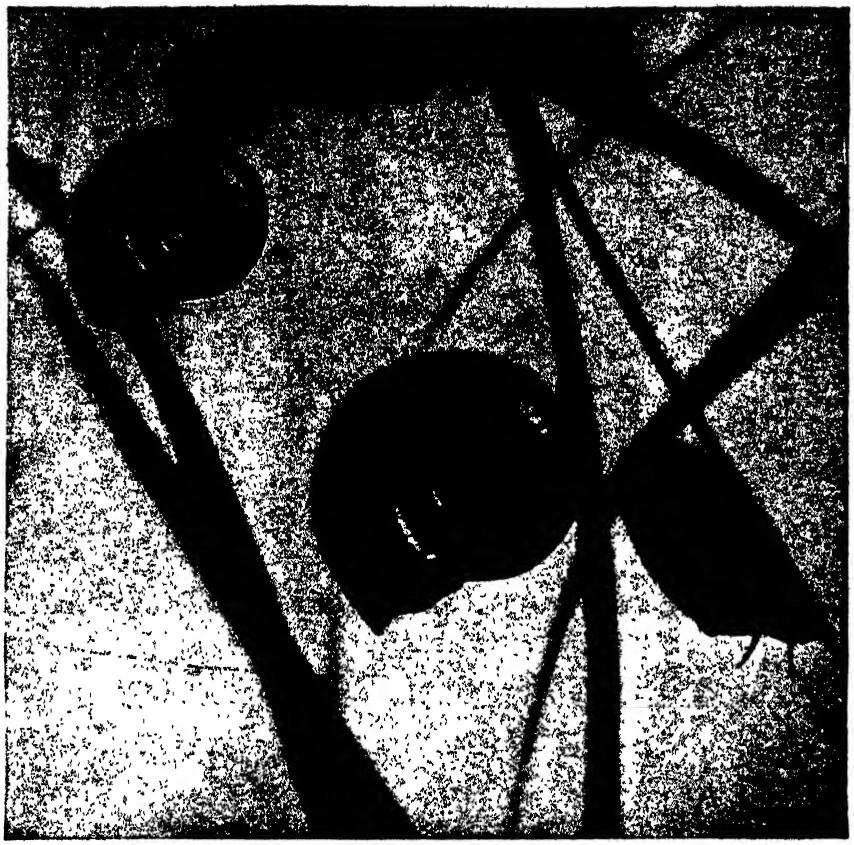


Grey slug

A pair of red slugs

SLUGS, LAND MOLLUSCS WITH HIGHLY MODIFIED SHELLS

In the slugs, what corresponds to the shell of the snail is reduced to a mere shield under which the head can be drawn in case of emergency. In the group, Arionidae, of which we have an example above in the centre photographs of Arion ater, the black slug, the shell is reduced to a few chalky grains beneath the mantle. The black slug relies on the fact that its skin is tough and unsavoury. The "black slug" may be yellow, brown, or red. The grey field slug (bottom left) is common all over Britain. Photographs by Bond, Ward, and Berridge



When once the worm has been secured, the rest is easy, for as the slug extends itself once more, the victim is gradually drawn into its body and eventually disappears.

The eggs have very thick shells, and are pointed at each end like those of a dabchick. They are large compared with the size of the animal, and although they are not bigger than a barley grain, a careful manipulator has been known to blow them with his mouth.

The worm-eating slugs are by no means the only carnivorous forms, for many other snails belonging to the same family—but with shells of many shapes and sizes which cover them—have also abandoned a vegetarian diet. A few others may also be mentioned, including the largest of the British glass-snails, which is also noteworthy on account of its blue skin. These forms can also elongate their bodies so as to reach up inside the shells of their

and the growth of the teeth of the rasp into long structures which are barbed like fish-hooks. The whole arrangement can actually be protruded for some distance from the slug's mouth. When this is done suddenly, it has a very striking, not to say startling, effect upon anyone who handles one of the creatures and is not aware of its capabilities.

It is when the animals are feeding, of course, that the apparatus is put to practical use.

; may imagine one of them crawling along in the burrow of an earth-worm, and if here it meets and touches the owner, both animals will recoil, and the contracted body of the mollusc will effectively block the passage. As nothing moves forward to meet the worm again, it becomes reassured and proceeds as far as the soft front of the slug, in which there may be a slight hollow. In trying to make its way through the obstacle, the pointed head-end of the worm may find its way, as Nature intends, into the depression and so tickle the slug. If this continues, the stimulation will cause the slug to open its mouth into which the depression leads and shoot out its worm catcher—the muscle already described. It is spoon-shaped at the end and the edges, which bristle with barbs, close inwards as the muscle comes to its full extension, so that not only does the anterior of the worm often get caught between them, but it is also impaled on the points, from which it cannot free itself owing to the barbs.

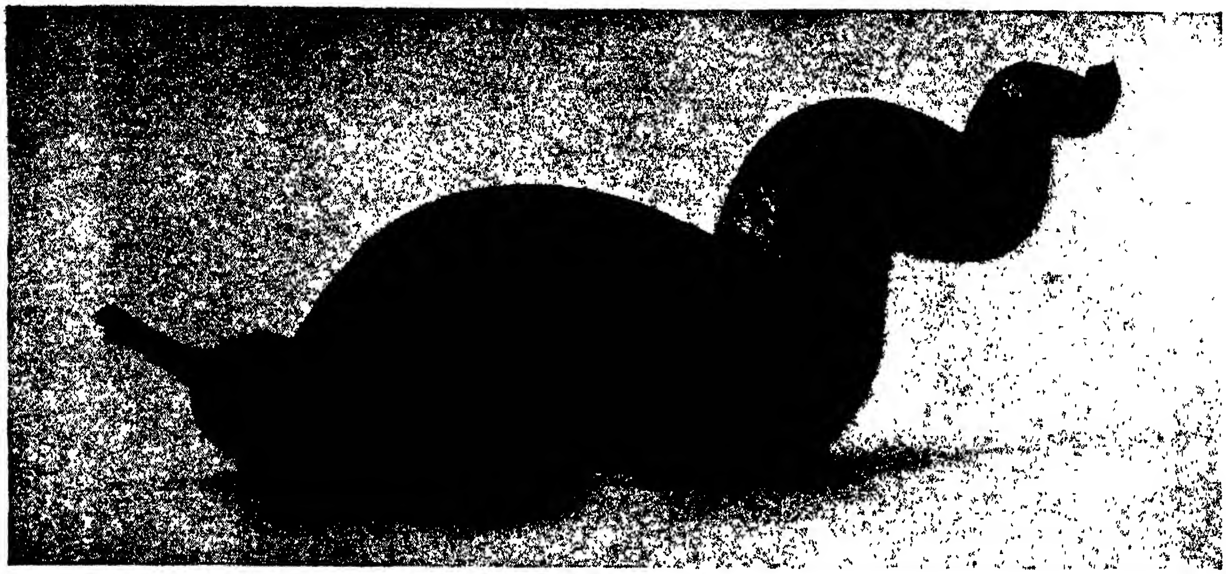
W. S. Berridge

WATER SNAIL FOUND IN POND AND DITCH

Of the water snails of Britain an important sub-family is that bearing the name Planorbis (flat coiled), and of this the Planorbis corneus is the largest. We see specimens here among some water weeds (top), and crawling up the side of an aquarium (bottom).

victims, and seeing the size of some of the Glandinas it is quite easy to believe that these may number as many as a dozen in a day.

We have already mentioned the land shells, more nearly related than our true snails to the whelks and limpets of the sea, having abandoned the water more recently. Their curious snouts recall their



F. W. Bond

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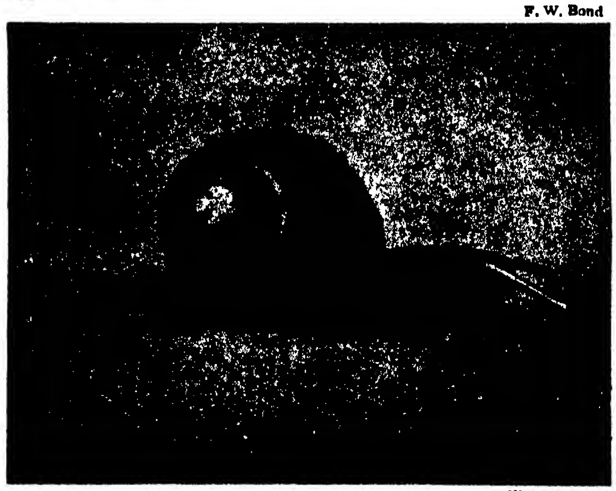


W. S. Berridge

NORMAL AND FREAK COILS OF THE GARDEN SNAIL'S SHELL

Below we see the normal form of the shell of the garden snail. Minor variations of banding and colour are common and, very occasionally, there may be an extraordinary freakishness in the actual coiling of the shell as it grows. The upper photograph shows an example of the ordinary garden snail like the one in the lower photograph, but which has had its spiral drawn out in a most astonishing way by some strange deviation from normal growth. The photograph shows the creature considerably enlarged.

gill-breathing relatives and forbears, although they are now quite adapted to a life in air.

There is an example found in chalky districts in this country not very unlike a small periwinkle, and its method of progression is very quaint. Instead of pushing forward the whole of its foot it moves each lateral half alternately, and crawls along as a man might make shift to walk if his ankles were not too tightly tied together.

INTERMEDIATE forms and those which can adapt themselves to varying circumstances have a special interest for students of nature, and the tropical apple snails are no exception. They still possess gills in addition to a lung chamber, and they enjoy an aquatic life, taking oxygen from the water or directly from the air through a tube, while in the dry season they can live on land. Their shells can at all times be tightly closed with a lid which is attached to their bodies and they seem to take advantage of any moisture that they can get. An explorer who kindly brought me several from places some two thousand miles inland in South America stated on his honour as an officer that they were discovered high up in trees in forks where the heavy dews that are common in that part of the world might trickle down to them.

The snails which we have been describing have two tentacles, and the eyes are not borne on the tips of these but are seated at the bases. We should also expect to find the same state of affairs in the fresh-water snails with doors to their shells, and not only is this the case with them, but also the air-breathing water-snails which have open mouths to their shells and come up to the surface for their supply are built in the same way.

Neville Kingston

LONG NECKS IN THE BIRD WORLD: SOUTH AMERICAN DARTER AND AUSTRALIAN SWAN

With the birds there is always a well-developed neck, even though this development is often not seen to advantage except in the skeleton. It is in birds that spend much of their time, or seek their food, in the water that we find the majority of long necks. The South American darter (left) for instance, seems rather overbalanced by its comparatively enormous neck when on land; but in the water the balance is seen to be perfect. Notice the curious angle or kink in the neck which seems to act like a spring and give an extra dash to the swift stroke of the beak when the bird makes the " dart " at its prey which has given it its name. On the right is a black Australian swan which holds its neck rather straighter than the European variety.

Chapter LXV

Long Necks and Short Necks

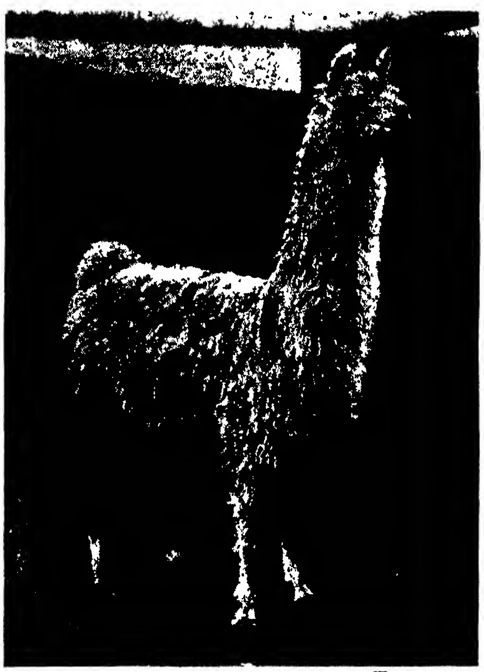
By Ruth C. Bisbee

Lecturer in Zoology, Liverpool University

A NECK is simply a narrow region of the body connecting the head with the trunk. A great many animals possess a neck in this sense, as, for example, bees and wasps, moths, butterflies and ants. In fact, all insects may be said to have both a neck and a waist for in all the body is divided into three regions—head, thorax, and abdomen, with constrictions in between.

In some insects, such as beetles, these constrictions are barely visible, and no casual observer would dream of speaking of either a neck or a waist. In the ants, on the other hand, both neck and waist are so excessively constricted that the creature appears to be in imminent danger of breaking into three pieces. Some of the more lowly creatures also have a neck in this sense of a mere constriction between head and trunk. The cuttle-fish and the octopus have clearly defined necks, as also have some of the water-fleas. The most vivid imagination, however, could not supply a shore crab with a neck.

The neck is best and most consistently developed amongst the backboned animals, and for this reason it is usual to think of a true neck as the neck of a vertebrate and to associate with it a fairly definite structure. The backbone together with the skull forms the axis of the whole skeleton, and naturally part of the backbone must pass through the neck. The backbone is divided into many small ring-like bones, the vertebrae, and these are specialised in structural detail in different regions of the body. Those in the neck, called cervical vertebrae, vary in number in different animals. The backbone is really a protection for the spinal cord, that part of the central nervous system which passes from the brain down the whole length of the body. The vertebrae are threaded on the spinal cord very much as beads are threaded on a string. Naturally the spinal cord passes through the neck, and it is the damage done to this cord when the neck is broken or dislocated which makes such an accident usually fatal. The food tube passing from the mouth to the stomach and the air tube passing from the mouth to the lungs also pass through the neck, as do the blood vessels of the head.



W. S. Berridge

SHAGGY-NECKED ALPACA

Belonging to the same family as the camel, but confined to South America, the alpaca has the characteristic long neck of its relatives. But a more erect pose is kept, the neck not sagging as in the camel's case.

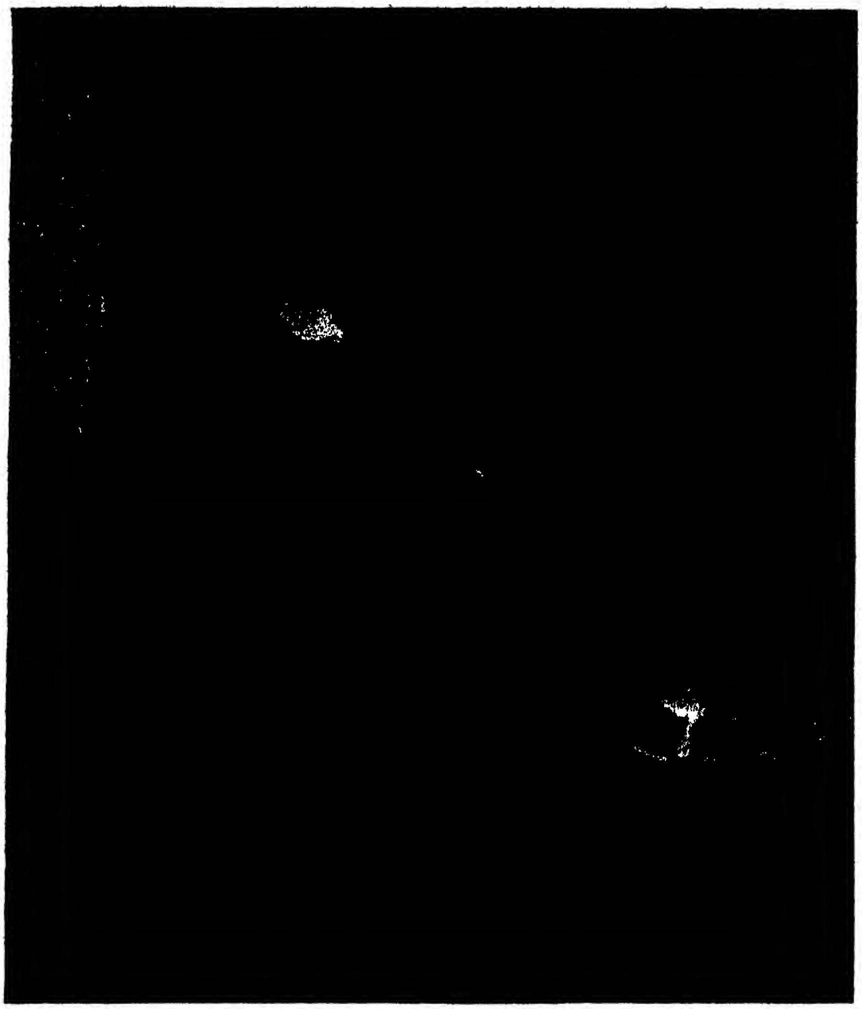
All backboned animals possess most of these structures, but the region containing them is not always narrowed to form a neck.

In fishes the body is very rarely narrowed behind the head. There are one or two cases where there is a slight constriction, as in the sea-horse, but this is unusual. The other extreme is found in the sunfishes and anglers, where the body is actually wider just behind the head than in any other region.

In the amphibia—frogs, toads, newts and salamanders—the neck is developed, but it is very short and it is not always possible to distinguish it, externally, from the rest of the body. In some frogs and toads, for example, the head passes imperceptibly into the trunk.

Amongst the reptiles the neck is much better developed. Internally the cervical vertebrae are usually quite distinct from the rest, but vary much in number in the different forms. Externally, too, the neck is usually quite well defined, but there is great variety in general appearance. In crocodiles and in most lizards, for example, it is very short and thick, whereas in tortoises and turtles it is usually comparatively long and thin and flexible. In snakes it is impossible to say from external appearances where the neck really ends and the tail begins.

In birds the neck is always well developed, but varies tremendously in form. The cervical vertebrae are usually distinct from the rest but, as in reptiles, they vary considerably from one species to another. In the small birds of fields and woods, such as the sparrow and thrush, the starling and the robin, the neck appears to be very short and thick. When the feathers are removed, however, the neck is seen to be very much better developed than at first appears, although it is not exceedingly long. The condition is similar in most British common wild birds such as crows and rooks, hawks, owls, pigeons, cuckoos, etc., but there are some with much longer necks, as, for example, ducks and geese, swans, cormorants and herons. Outside the British Isles there is even greater variation, from the short-necked penguins to the long-necked storks and cranes and flamingoes.



Autotype

MASSIVE SHAGGY NECK OF THE AMERICAN BISON

The bison is remarkable for its ponderous shoulders, massive neck and strong, aggressive-looking head, and the more so as the hind quarters are much more slender than a mere view of the head and neck would suggest. The distinctive hump of the back is caused by the exceptionally long vertebrae joining the head to the body, and the neck itself is covered with shaggy hair.

The neck is often elaborately ornamented. There is a lizard in Australia which has a large frill of skin on each side of the neck, the two halves being joined together in front of the throat. This frill can be raised until it looks like a wide and elegant collar, or it can be lowered until it looks like a cape worn back to front. The cobras make themselves both handsome and terrifying in appearance by expanding the neck region into the famous hood. In many birds the neck is very beautifully decorated. In some the decoration consists simply of more brightly-coloured feathers than are found elsewhere on the body, as, for example, in male ducks. In others the feathers of the neck are specially long and loose, and in storks and herons and cranes they hang down loosely in front forming a kind of jabot. Others, again, wear a ruff as, for example the ruff itself, which has around the upper part of its neck a broad band of feathers which can be raised or lowered at will. In mammals, too, the neck is often ornamented. The lion's mane is a most handsome ornament and the quite different type of mane found in all members of the horse tribe is almost equally handsome and decorative.

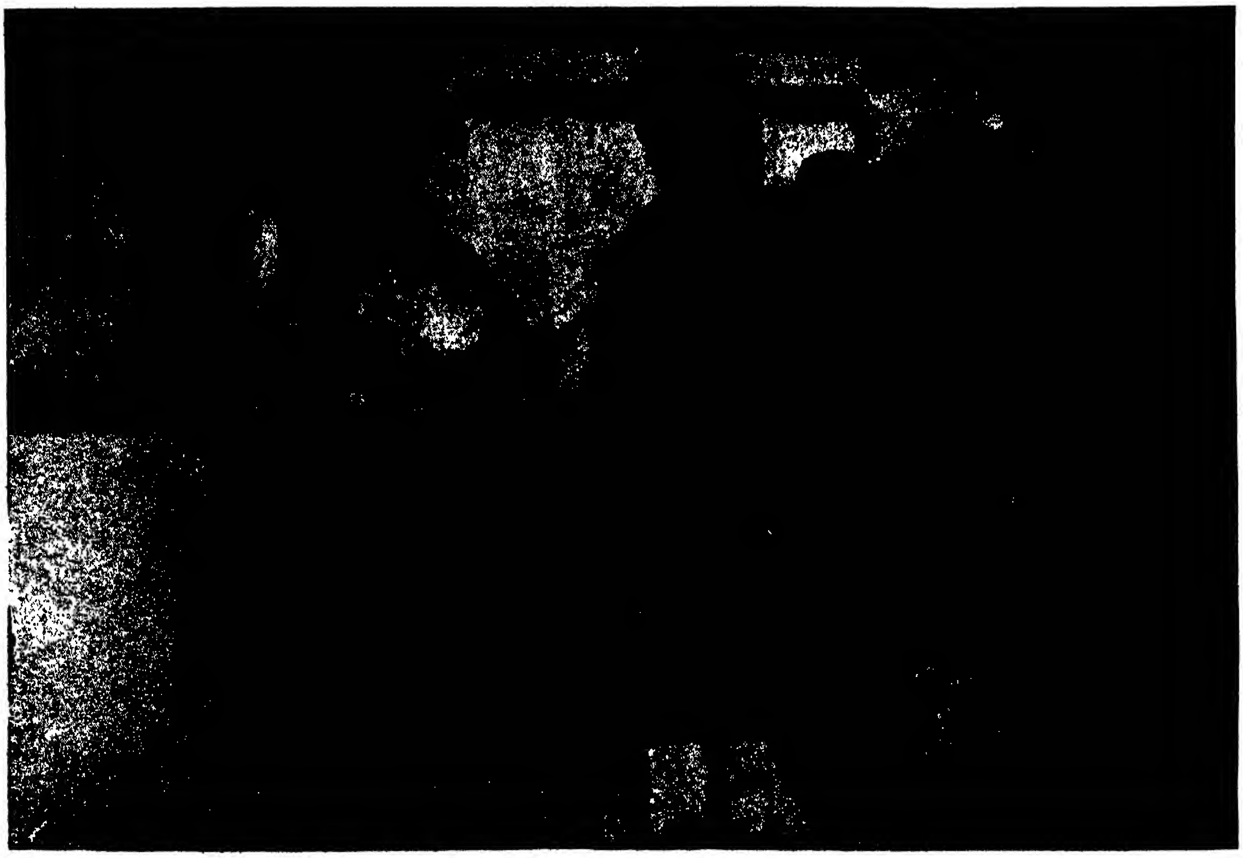
Further, there is almost endless variety merely in the poise of the neck, especially in the way long necks are carried when their possessors walk or swim or fly, and in the way they are disposed of during rest. During flight, most birds stretch the neck straight out in front, and so perfect the stream-lines of the whole body. Ducks and geese and even flamingoes fly in this way. Herons, however, fly with the neck bent in the shape of an S, with the head drawn well back. Except during flight nearly all necks are bent, and most of them assume this S-shaped curve. In some one limb of the S is emphasised, in others another, but in nearly all the curvature is essentially the same. In the swan the S is evenly balanced and indeed the grace of the beautiful neck is proverbial.

In mammals the neck has a more definite structure than in any other creatures. Nearly all mammals have seven cervical vertebrae. The manatees have only six, and sloths may have six or eight or nine but, apart from a very few exceptions, in mammals the neck contains seven vertebrae. The form of the neck, however, varies greatly. There is the short thick neck of the whale which, from external appearances, would not be called a neck at all; the strong short neck of the elephant which is so admirably suited to carry the enormous weight of the head and tusks; the graceful curved neck of the horse; the ungainly-looking long neck of the camel, and the enormous tower-like neck of the giraffe. Yet in the giraffe and the whale alike there are seven neck vertebrae, neither more nor less.

Thus there is great variety in form in the neck region throughout the backboned animals, and the variation does not by any means end with differences in length and thickness.

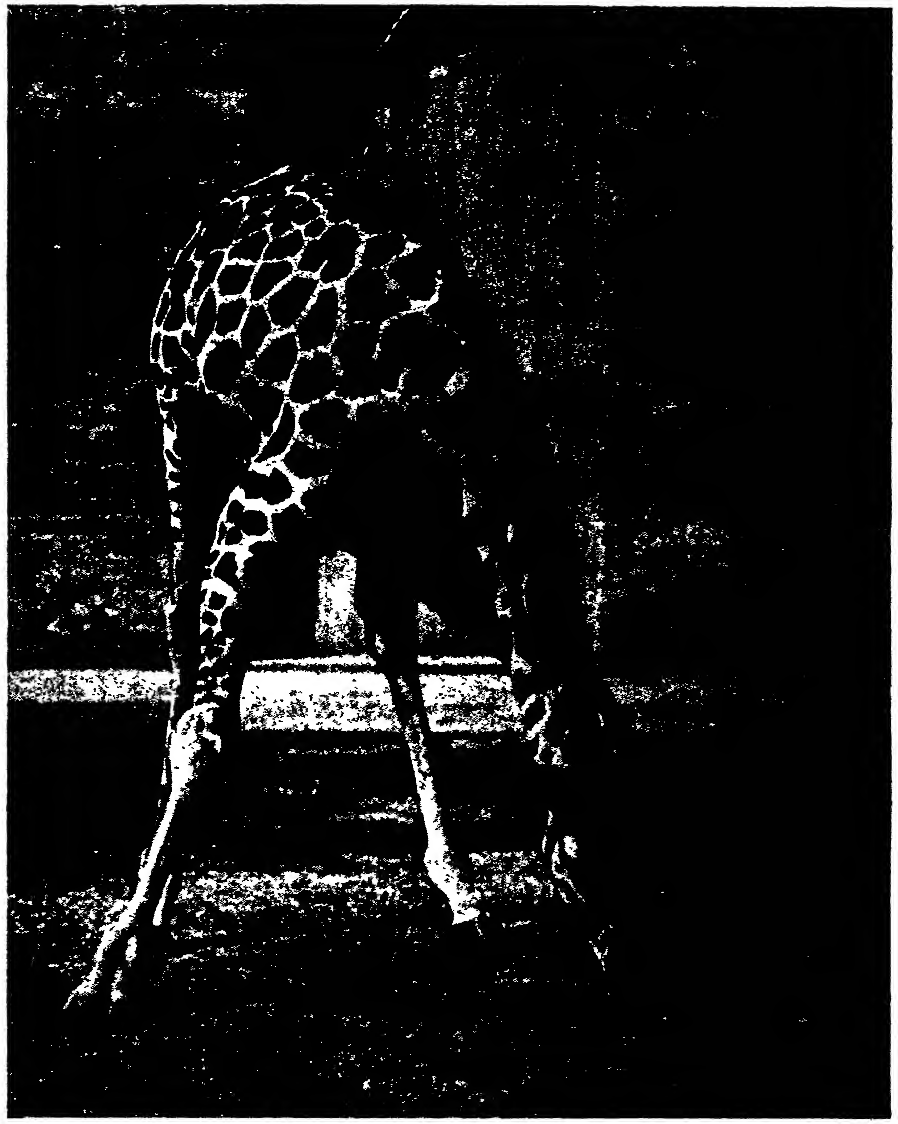
In the giraffe the head and tail of the S are very short, the middle part very long and little curved, and the whole neck stands up awkwardly from the body like the arm of a mechanical crane. In tortoises and turtles the curvature of the neck is un[illegible] Most

Neville Kingston



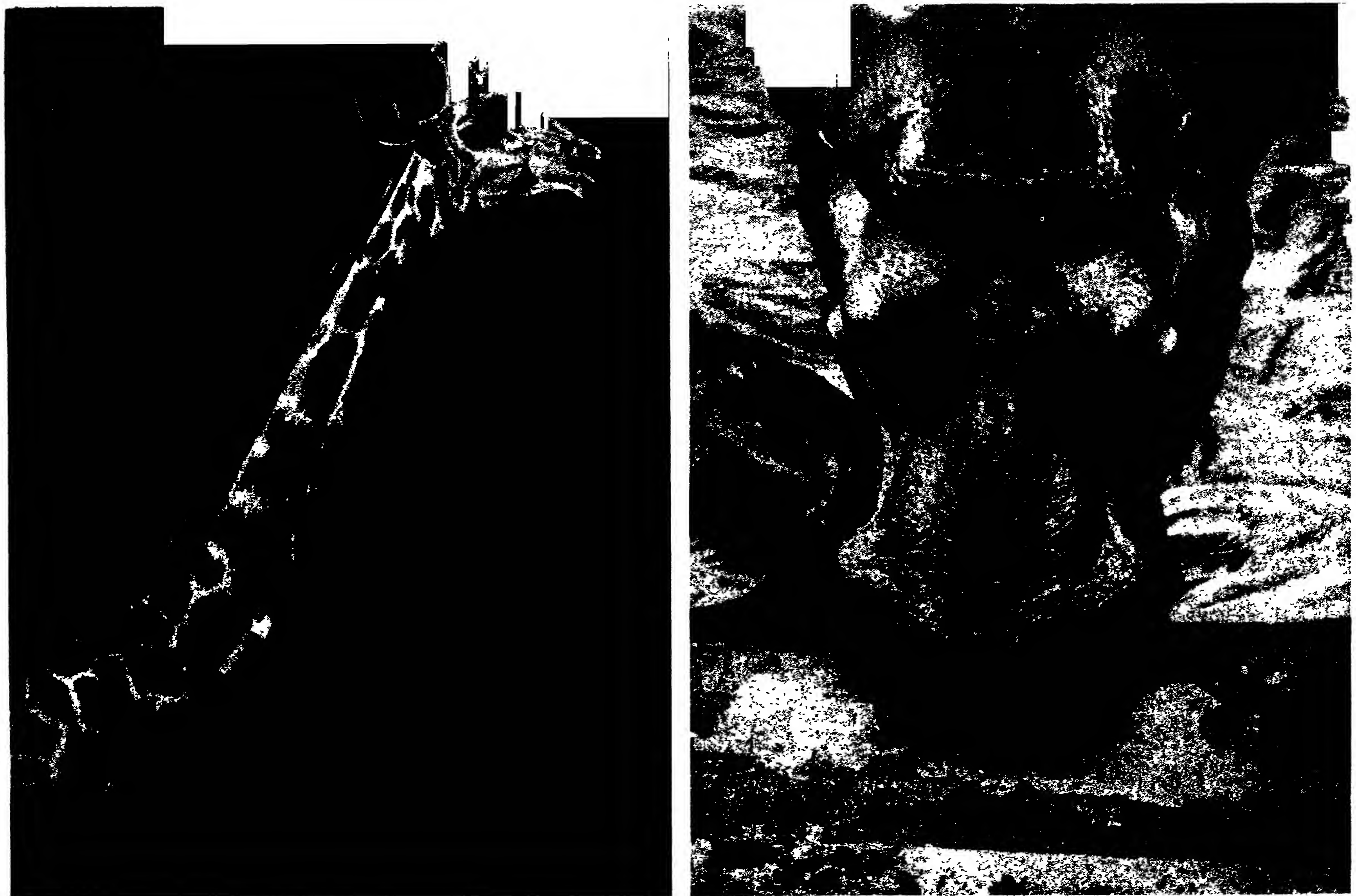
HEAVY-ARMOURED NECKS OF RHINOCEROS AND CROCODILE

Nature seems to have gone out of her way to make the neck of the rhinoceros invulnerable. Great folds of immensely tough hide envelop the neck, which is really longer than, at first sight, it seems to be. The heavy head tends rather to droop slightly when the animal is standing at rest. The crocodile (top), equipped with scale armour, is just as strongly protected. In fact, the bulge of the neck partly envelops the great jaws. The crocodile's neck is the handle of one of the most dreadful weapons owned by any animal.



EXTREME LIMITS OF THE "REACH" OF A GIRAFFE'S LONG AND TAPERING NECK

The giraffe is almost exclusively adapted for feeding on vegetation which would be out of reach of any other animal save, perhaps, the elephant which has the masterful habit of pulling down a tree whose leaves are too high for it to reach. What the giraffe can do when it tries is admirably illustrated here (left). The tree has been guarded by railings, but the giraffe easily overtops them and browses contentedly on branches from seventeen to twenty feet above the ground. But when it is a question of picking up food instead of reaching for it, or of obtaining some water, the neck, long as it is, is not quite long enough, and so the animal has to splay its forelegs as we see here (right).



James

THE LONG AND THE SHORT OF NECK DEVELOPMENT: GIRAFFE AND HIPPOPOTAMUS

From the structural point of view, the neck is the connexion between body and head and its support is the spine, made up of sections of bone called vertebrae. The vertebrae of the neck are called cervical, and in most mammals there are seven cervical vertebrae. The whale, which has exteriorly an ill-defined neck, has seven and the giraffe, at the opposite end of the scale, has seven also, the difference in length being accounted for merely by the length of the individual vertebrae, or portions of the spinal column. The hippopotamus (right) has a neck thick enough to support its enormously heavy head and the neck is very short. Nevertheless, it has the same number of cervical vertebrae as the giraffe.

excellent series of animals built essentially for life on land, but modified more and more for life in the water.

The advantage of the torpedo shape for a creature living and moving in the water is too obvious to require explanation. Man has yet to discover a more perfect shape for a body which is required to move quickly in this medium, and it is significant that so many creatures living in the water approximate to this shape. Whether the shape has developed as a result of life in the water, or whether water has been resorted to because the animals have varied in a direction which fits them for this habitat is a much debated question.

A. H. Hall

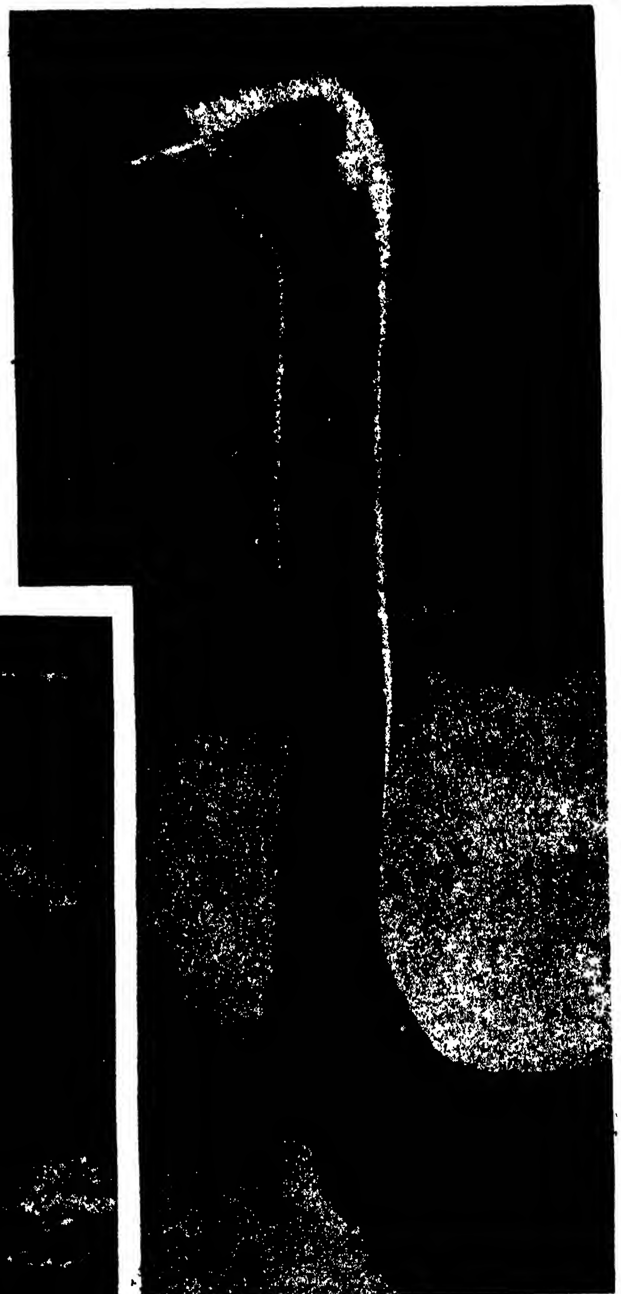
POSTURES OF THE PELICAN'S NECK

While clumsy and, to human eyes, a little ludicrous on land, the pelican is very active in the water. The stretching power of the neck is well shown in the lower photograph where the long neck is enhanced by the length of the beak. The long beak (above) makes up for a long neck when breast feathers need preening.

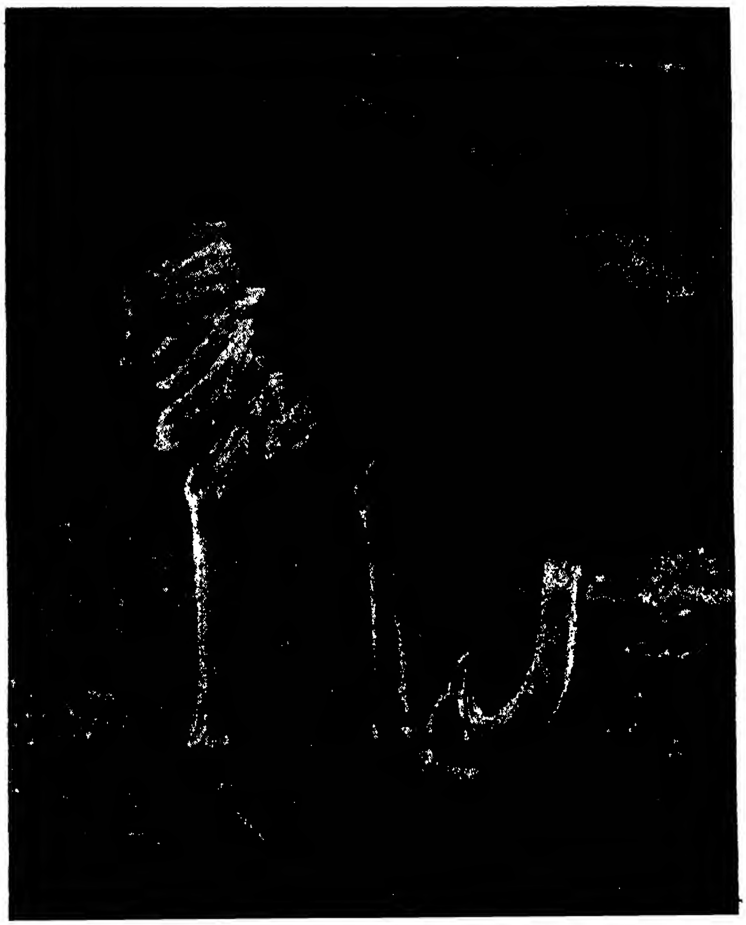
of the mammals, but these are very much shortened and flattened from back to front until they are like a series of plates. The dugong, another mammal which lives entirely in the water, also has an extremely short, thick neck and the body tapers posteriorly and is somewhat fish-like in shape, though much less so than that of the whales. Seals, too, are mammals which live most of their lives in water, and here again the body is rather torpedo-shaped with the neck strong, short and thick.

The powerful and forbidding-looking walrus spends much time in the water and is also, to some extent, torpedo-shaped. In fact, the walrus, seal, dugong and whale form an

In regard to terrestrial animals it is also possible to see a connexion between the mode of life and the length of the neck. It seems to be a general rule that those creatures which live in vast, open spaces and have to travel great distances have long legs. There is the camel which travels across wide deserts; the ostrich which lives on the open, arid tracts of Africa, and the giraffes which live in the same regions—all with long legs suitable for covering great distances, whether in fleeing from enemies or in search of food. And if the legs are long, there must be some device to enable the creature to reach the ground with its mouth for food and water. In the elephant there is the trunk; in the curlew there is an extremely long bill; but in the vast majority of cases there is a long neck for the fulfilling of this purpose.



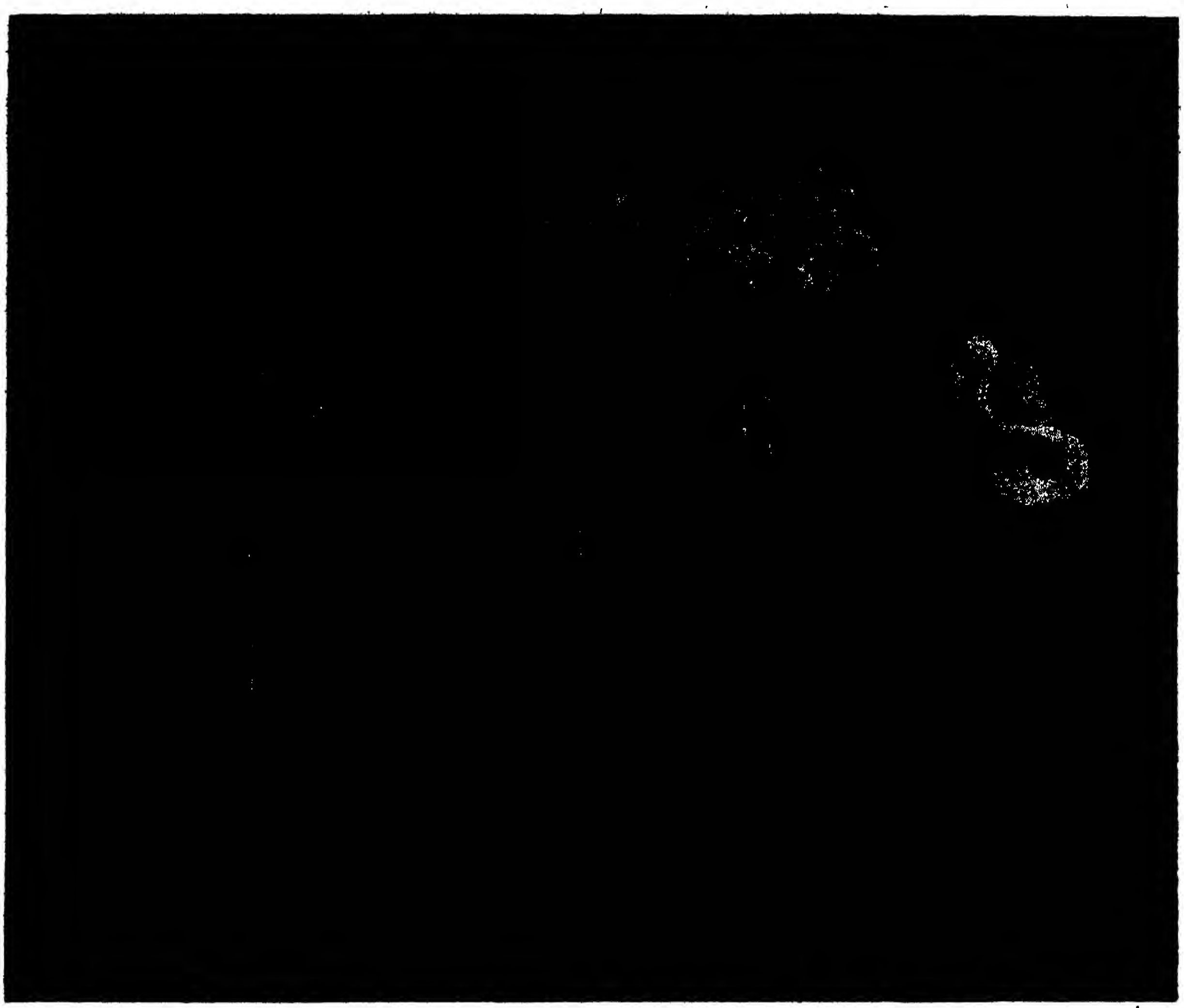
Even in the giraffe, which finds its food on the high branches of trees, it is still necessary that it should be able to put its mouth to the ground in order to drink. As a matter of fact, the giraffe's neck is barely long enough for this purpose, with the result that its characteristic attitude, when drinking, is extremely awkward. It places its front legs widely apart and stretches its neck down between them.



OSTRICH, A BIRD CONTORTIONIST

Long legs need a long neck to enable the head to reach the ground for feeding. But the ostrich's neck is capable of more than just enabling the beak to pick up food. It is even possible for it to be bent into a pot-hook at the bird's pleasure (bottom). Above is the ordinary and rather dignified carriage of beak and head.

The same correlation between long legs and long necks is found amongst wading birds and is here strikingly associated with the method of obtaining food. Birds like storks, herons, and flamingoes live on aquatic creatures, but cannot dive for them. They wade out into deep water in search of food, and their long necks enable them to reach it.



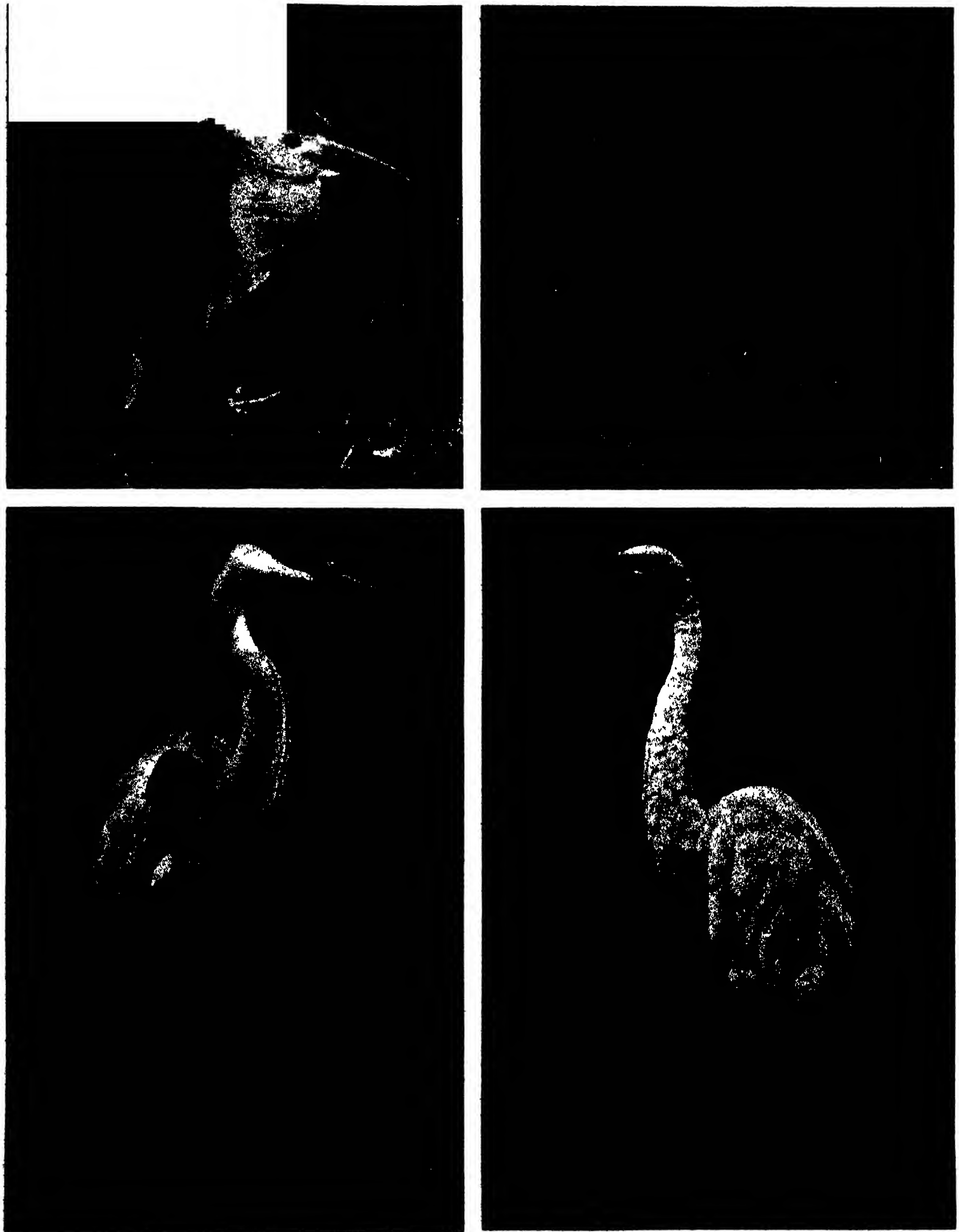
James

FLAMINGO NECKS IN SLEEPING AND SWIMMING

One of the many delightful things about the flamingo is the eccentric but graceful pose which the bird takes up when resting (top). The neck has a kind of double twist in it as it lies like a snake along the back between the folded wings. When the bird is swimming the join of the neck and body is submerged (bottom), an unusual feature in swimming birds.

Nearly all animals with long legs have long necks, but by no means all animals with long necks have long legs. There were the ancient reptiles, the Plesiosaurs, already mentioned, which had enormously long necks, yet their limbs were short paddles. There are the swimming birds like ducks and geese and swans, pelicans and cormorants, all of which have long necks and short legs. These birds swim about in search of food and either dive for it like the cormorant or, like the swans, stretch down their long necks through the water and explore in the mud below.

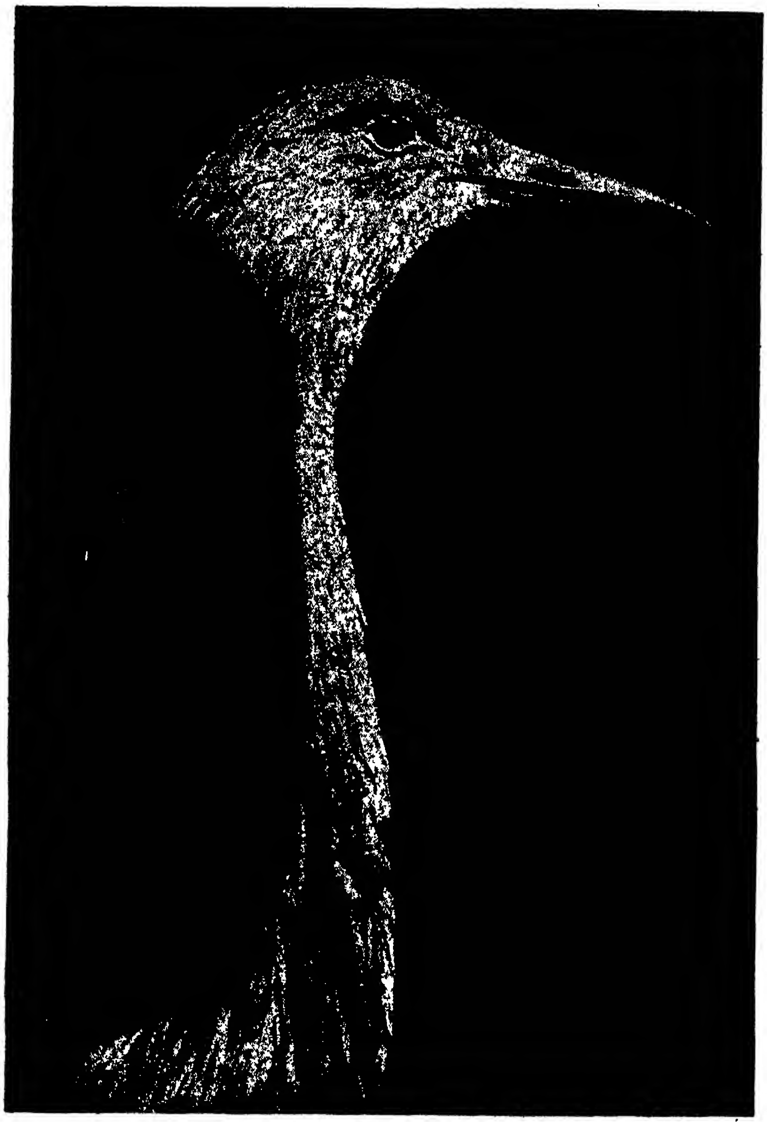
Thus there is a very close correlation between the mode of



James

HERON NECKS ON THE ALERT AND WHEN RESTING

A peculiarity of the heron's neck is that it is tightly bent, during flight, into an "S," the head being held well back, whereas other long-necked birds stretch their necks while they are flying. A similar position is taken up when birds are at rest (top) though on alarm or when fishing the neck is quickly erected (bottom). These photographs show (bottom left) a cocoi heron from Para; an egret, a white heron from the New World (bottom right); a nankeen night heron (top left), and a garden night heron (top right).



CURIOUSLY SHAPED NECK OF THE STANLEY CRANE

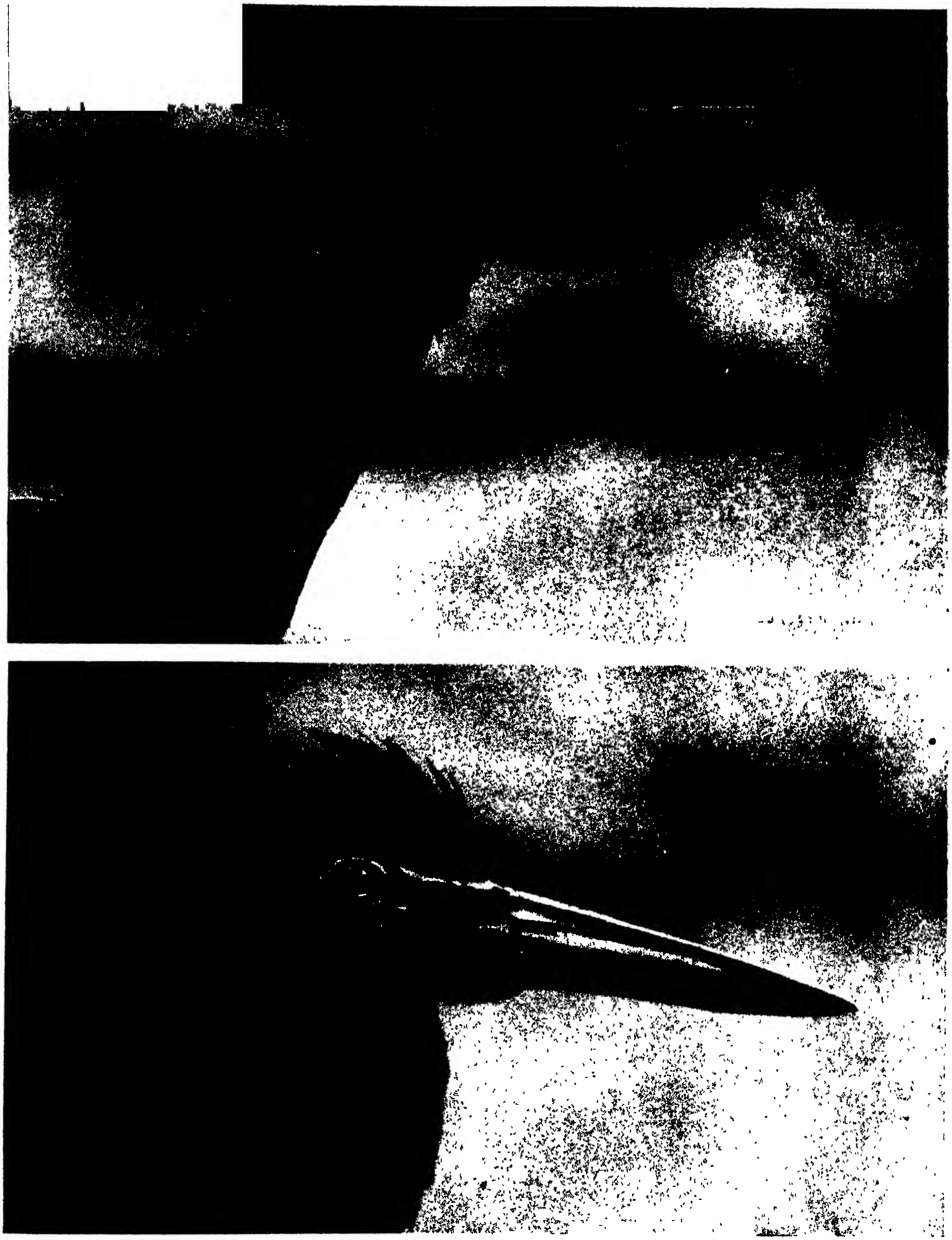
Inhabiting the more open country in South Africa, but nowhere very common, the Stanley crane has an unusual neck which, gradually continuing the line of the body at the base, dwindles in the middle and then swells quickly to meet the curiously thickened head The Stanley crane is carnivorous in its habits.

life and the shape and structure of the body, and nowhere is this correlation more striking than in regard to the neck. How this correlation has come about, however, we do not know, but two main theories have been put forward to explain it.

According to Darwin, evolution has taken place by a process of natural selection. He pointed out that no two living things are alike, and that many more creatures are produced than can be supported on the available food. He argued that there must, therefore, be a struggle for existence, and that in that struggle the fittest would survive, the unfit being exterminated. He took for granted that the survivors would hand on their own characteristics to succeeding generations, and that, in this way, distinct races would be evolved, each specially fitted for its own particular environment. The giraffe, for example, may conceivably have evolved in this way. Amongst its deer-like ancestors there would undoubtedly be insufficient food at some time or other, and there would then be competition. Amongst these creatures some would certainly be a little taller than others. With their longer legs they would be able to go farther afield in search of food than their shorter relatives, or with their longer necks they would be able to reach the shoots and leaves on the upper branches of trees, beyond the reach of their companions. These slight advantages might make the difference between life and death in times of great stress, and so the taller ones might live while the shorter ones died of starvation. If the taller ones handed on their tallness to their offspring, and if these again varied among themselves, some being even taller than their parents, and if the struggle continued, the advantage still remaining with the tall, gradually a very tall race might be evolved, such as the present-day giraffes.

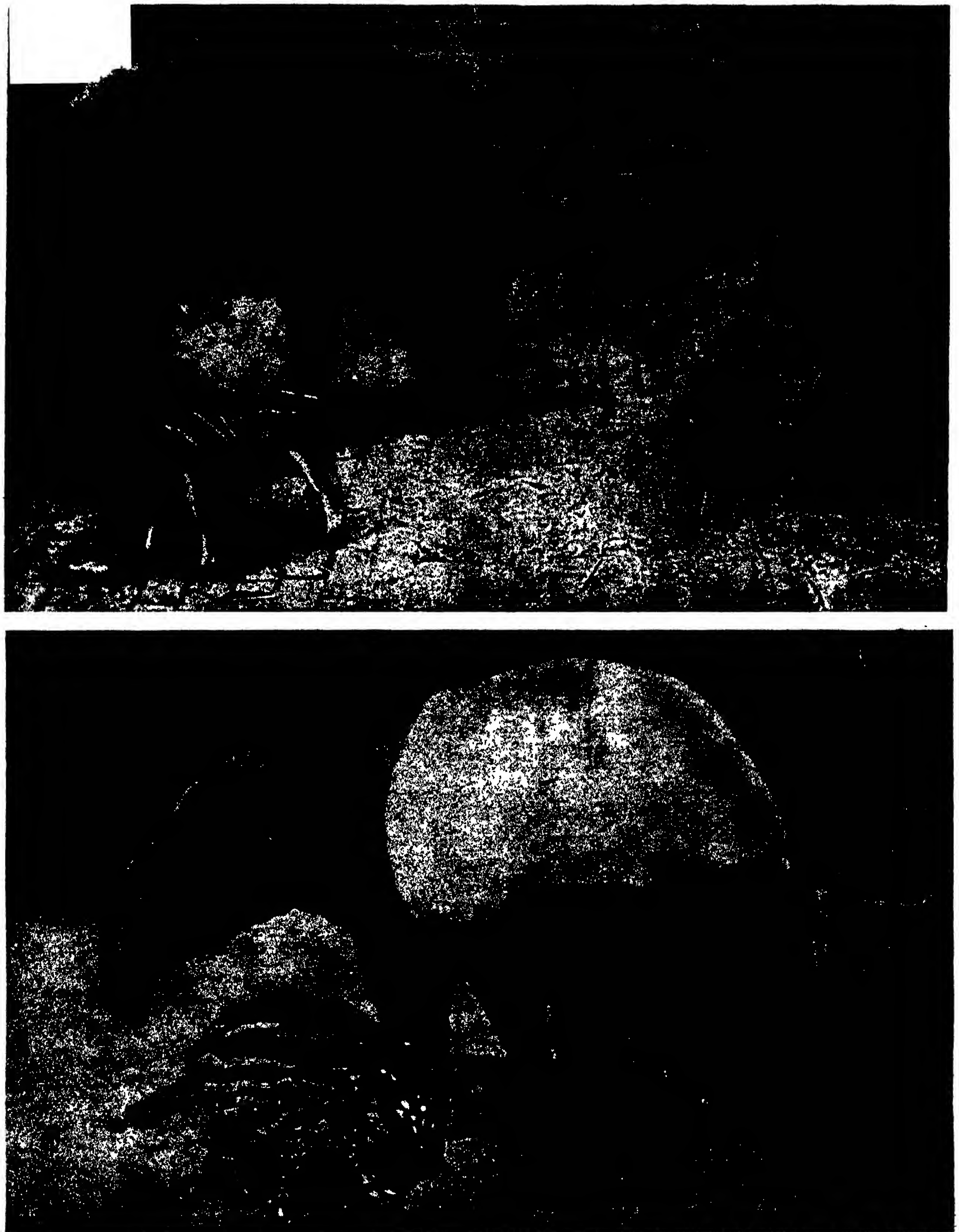
Lamarck, on the other hand, believed that evolution has taken place as a result of the striving of each individual to meet the demands of the environment. We know that use causes an organ to develop, and that disuse causes it to atrophy. Lamarck took for granted that the effects of use and disuse on the individual would be handed on through succeeding generations, and that in this way different races would be developed, each one perfectly fitted to meet the demands of its own environment. According to this theory the giraffe has evolved as a result of constant striving on the part of its ancestors to reach the fresher vegetation which is found near the tops of trees. Some of the deer-like creatures of the past quite likely did stretch upwards to reach fresh, juicy leaf-buds and young shoots. By so doing they would almost certainly increase their height to some slight extent. If this increased height were transmitted to their offspring, and if these in turn again stretched upwards for their food and so added a little more to their height, then gradually a taller race would evolve which might well give rise eventually to the giraffe of our own day.

Theoretically, then, both long necks and short necks could have evolved as a result either of natural selection or of the inheritance of the effects of use and disuse. There are, however, difficulties in the way of accepting either theory as a complete explanation.



TIGER BITTERN AT REST AND WHEN READY TO STRIKE

When the tiger bittern becomes excited the feathers on its neck, which are long, become fluffed out, so that the neck looks much thicker than it really is. This process leaves the back part of the neck uncovered save for a fine down. The thrust of a bittern's beak is like a dagger stroke, for the long neck is suddenly flung out as though a strong spring had been released. A wounded bittern is best left alone. The bird, celebrated for its booming note, is now very rare in Great Britain, though formerly plentiful.



W. S. Berridge

TRANSFORMATION OF MARKINGS FROM ADOLESCENT TO ADULT

If structural features have changed in any particular class of animals during the long process of evolution we can well imagine that the markings of the coat or hide have changed. It is believed that the young animal repeats, as it grows, the life story of its race. If this is so we must conclude that the Malay tapir (bottom) was once striped as its young now are. The very different markings of the adult animal are extremely striking. In the Indian wild swine (top) the adult's back is uniformly dark while the young have parti-coloured backs.

Chapter LXVI

The Wonder of Animal Transformation

By J. R. Ainsworth-Davis

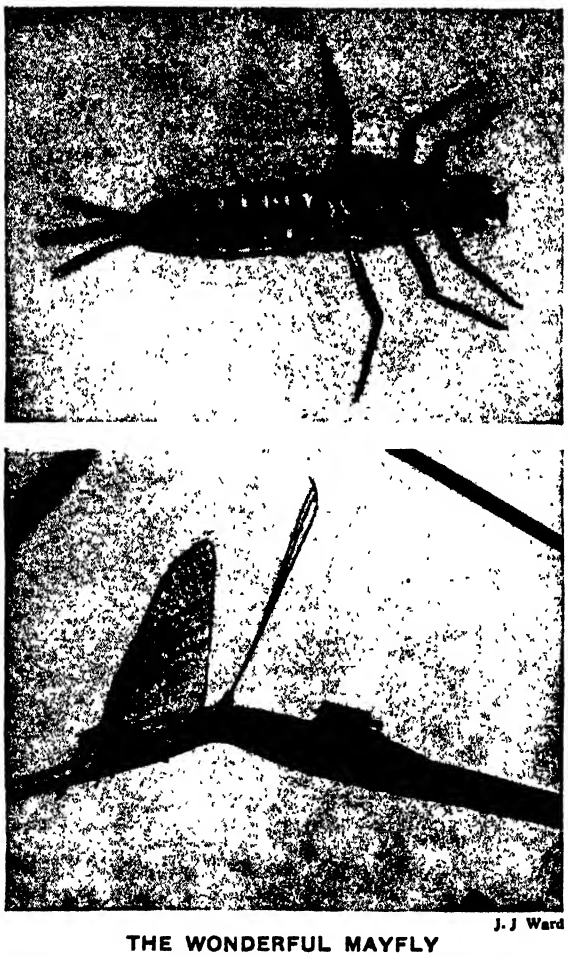
Formerly Professor of Zoology, University of Wales

AMONG the wonder-tales of mythology, legend and fairy lore are many based on the belief that startling transformations of human beings into wolves or other animals were events of common occurrence. Such tales have always appealed to the imagination, and some of them will be remembered by every reader. They may be found in the "Metamorphoses" of Ovid ("metamorphoses" simply means "changes of form"), the "Arabian Nights," and many of the fairy tales that are always popular in the nursery.

Science has laid a ruthless hand on the beliefs of our forefathers, but she has made ample compensation by demonstrating that "truth is stranger than fiction," and the story of animal transformations is far more wonderful than any product of human imagination. By studying the life-histories of animals we shall find that many forms are startlingly unlike their parents when they make a start in life, and only attain adult characters by passing through a series of well-marked changes amounting to a complete metamorphosis.

A young animal strikingly dissimilar from the adult form when it begins life is called a "larva," the Latin word for ghost or spectre, the name being meant to suggest an obscure foreshadowing of what is to come. The most familiar examples are to be found in the insect world, and every one knows that the egg of a butterfly hatches out into a voracious larva called a caterpillar, this later on becoming a motionless chrysalis from which the adult insect (imago) ultimately emerges. The question "Why?." here naturally arises, and the answer partly explains not only this, but all other cases of metamorphosis.

The caterpillar is suited or adapted to conditions quite different from those which dominate the existence of the adult. It has to lead a special life of its own, and characters having relation to that life are dropped later on, new ones being acquired to meet the needs of the adult. The business of the caterpillar is to feed on vegetable substances that require chewing, and it possesses powerful biting jaws for the purpose. Wings are not wanted. The duty of the butterfly is to provide for continuance of the species, and wings help it in the search for a mate. The gross feeding habits of the caterpillar are abandoned, and biting jaws replaced by an elegant trunk or proboscis, used for sucking light refreshment consisting of the nectar provided by flowers. In the intermediate resting or chrysalis stage of life the body of the caterpillar is completely remodelled into that of the adult insect.



J. J Ward

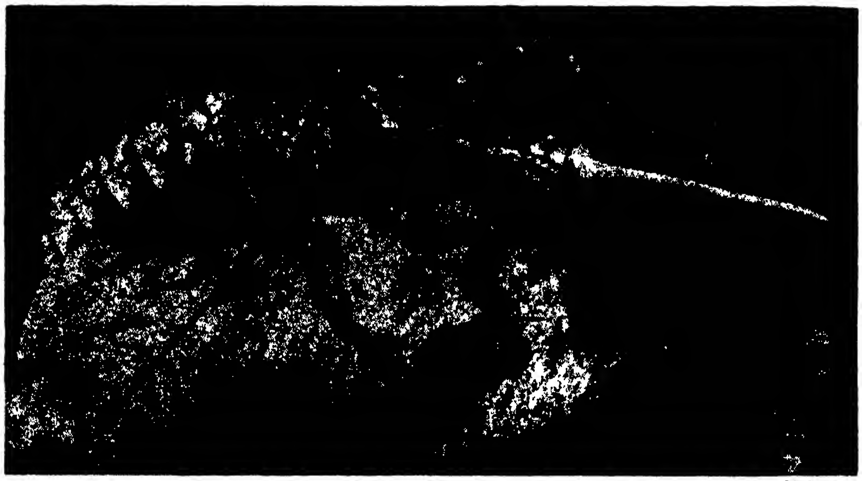
THE WONDERFUL MAYFLY

Although we know it as the most ephemeral of creatures, the mayfly's life is not so very short. Below the water in the larval stage (top) it spends many months and only emerges at the end to breed, equipped for that purpose and no other (bottom).

There is no larval stage in the highest groups of backboned animals—mammals, birds and reptiles—though in certain cases the young are born or hatched in a somewhat imperfect state. A baby, for example, is obviously a human being, so we do not call it a larva; nor do we apply that term to a helpless nestling bird. It is quite otherwise with the Amphibia, backboned creatures of which the best-known examples are newts, salamanders, frogs and toads, often erroneously called "reptiles." When grown up they possess soft and slimy skins, but have no scales and very rarely any claws.

The life-history of Amphibia is of particular interest, and proves that evolution is a possibility. No better text from which to preach Darwinism could be selected. The schoolboy who asserted that these creatures "die on the land and cannot live in the water" must have been ill-instructed in natural history, for we all know that they hatch out as aquatic tadpoles or pollywogs (larvae) which are ultimately transformed

into land animals, though these are as a rule quite at home in the water as well. Let us take the frog as our most familiar native form of the kind. In spring the eggs (frog spawn) are laid in ponds, and the tadpoles hatch out in due course. They are adapted to life in water, and in many ways resemble fishes in structure, breathing dissolved air by means of gills, and being devoid of fore and hind limbs such as are present in the adult frog. As in a fish, the heart contains only impure blood, and pumps this to the gills for purification. After a time the tadpole is gradually transformed into a frog by a series of far-reaching processes of growth. The gills shrivel up, and as they do so a pair of lungs for breathing ordinary atmospheric air is developed. Fore and hind limbs grow out, the tail is absorbed, and the tadpole has now become a tiny frog which continues to grow until it attains its proper adult dimensions.



M. Duncan

SMALL SWIMMING CREATURE THAT TURNS INTO A LOBSTER

Lobsters, when first hatched, look very different from their parents. They escape from their eggs as swimming creatures which rise to near the surface, moving by means of the oar-like appendages on their legs The transformation is achieved by a series of moults, stage succeeding stage (top), till the perfect creature sinks down to a life in the depths (bottom).

In the course of its life-history an animal is believed to repeat, in a general kind of way, the evolutionary stages passed through by its ancestors; or, in other words, "climbs up its own genealogical tree." It can therefore be concluded that the frog and its kindred have descended from fish-like forms, and it may be added that certain details in the structure of reptiles, birds and mammals can only be explained by a similar hypothesis.

The axolotl, a distant cousin of the frog, has a story to tell which is quite a romance. It is a newt-like creature with three pairs of delicate, feathery gills growing from the sides of the neck, and abounds in the lakes surrounding the city of Mexico. It lays eggs which hatch out into tadpoles that grow into axolotls, and from its first discovery by the Spanish conquerors of Mexico in the sixteenth century until 1865 it was not considered especially remarkable, except by the great French naturalist, Cuvier, who anticipated subsequent discoveries now to be described.

Certain tailed amphibia, allied to newts but more addicted to terrestrial life, are known as salamanders, and a common European form was believed in the Middle Ages to be "bred and nourished by fire." The tiger salamander (*Amblystoma tigrinum*), so called from the yellow streaks and blotches on its dark skin, ranges from New York to California and Mexico, and until 1865 nobody suspected it had anything to do with the axolotl. But in that year some axolotls kept in Paris lost

ERRANT FINS OF THE FANTAIL FISH TRANSFORMED FROM THE NORMAL

By means of careful interference with the course of Nature during centuries there have been produced, by breeders in China and Japan, finned grotesques such as this which exist solely to satisfy the aesthetic appreciations of those who brought such very special gold fish into being. The artificial multiplying of the fins produced a transformation from natural utility to a humanly evolved decorativeness

To face page 712

their gills, and underwent other changes by which they were converted into tiger salamanders. Several ways of bringing about this transformation are known, and the axolotl is now regarded as a sort of permanent tadpole which has grown limbs and taken to egg-laying, thus cutting the adult stage out of its life-history. Who can say how many sorts of animal have done the same thing? Perhaps we ourselves are nothing but human axolotls!

Many fishes hatch out as larvae or "fry," differing greatly in appearance from the adult, as in the case of the salmon, a marine form which ascends rivers to spawn. This species begins life as a tiny alevin, about one 25th of an inch long, with a little bag of nutritive material (yolk) projecting from the under side of its body. Before the adult characters are fully attained several further stages have to be passed through—parr, smolt, and grilse—and this takes several years to effect.

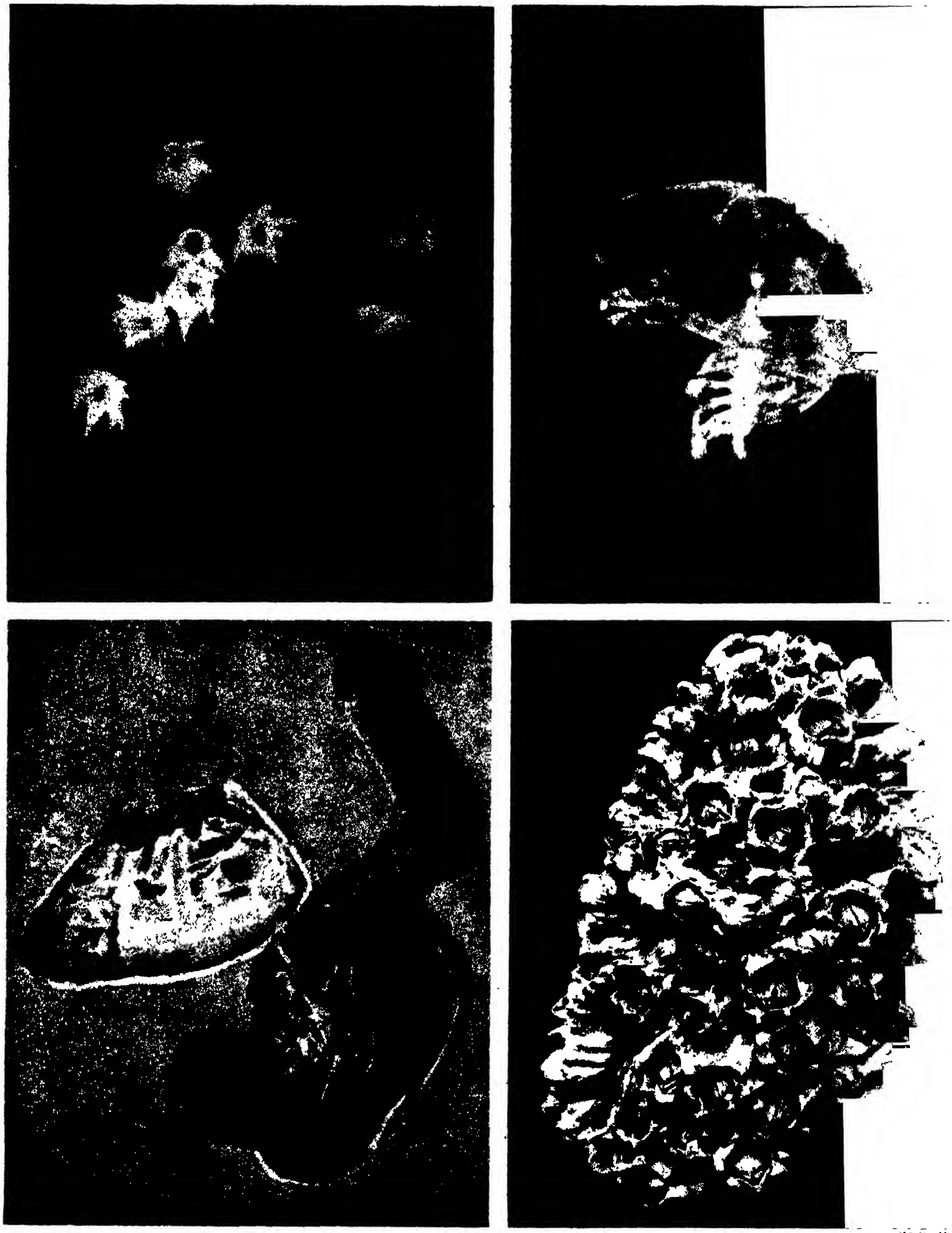
M. Duncan

CRAWFISH: ITS LARVAL AND ADULT STAGES

In their early stages crawfishes have a superficial resemblance to spiders. Their bodies are broad and very thin, and also have a transparent quality which, in the larger forms found swimming in tropical waters, has earned them the misleading name of "glass crabs." After several moults the spider or crab-like appearance is lost and the eventual physical characteristics are assumed.

The story of the common eel is far more remarkable, but was very imperfectly known until 1897. Even yet there are gaps to fill. The older naturalists were aware that spawning does not take place in fresh water, and suspected that eels migrated to the sea for that purpose, especially as vast numbers of tiny eels, or elvers, ascend our rivers in spring and early summer. This annual movement is known as the "eel fare," and is particularly noticeable in the Severn estuary, where at one time elvers were regarded as a particularly dainty food, either stewed or fried,

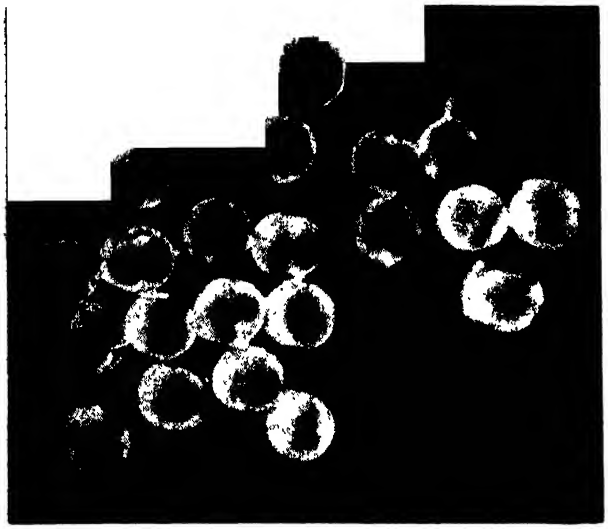
This is what happens. Male eels spend five and a half to six and a half years in fresh water, and female eels six and a half to eight and a half years, before attaining maturity, when they assume a silvery appearance. These "silver eels" descend our rivers to spawn in the Atlantic during winter and spring at depths of not less than five hundred fathoms. They probably die when the eggs have been laid, but at any rate do not return to their old homes in fresh water. It is believed that these eggs float and hatch out at the surface. However that may be, there is no doubt that a little, transparent fish-like creature, formerly classified as a distinct species (*Leptocephalus brevirostris*), is really a larval eel, for in 1897 two Italian naturalists kept specimens under observation and witnessed their transformation into elvers. (The strange story of the eel is told at greater length in Chapter V.)



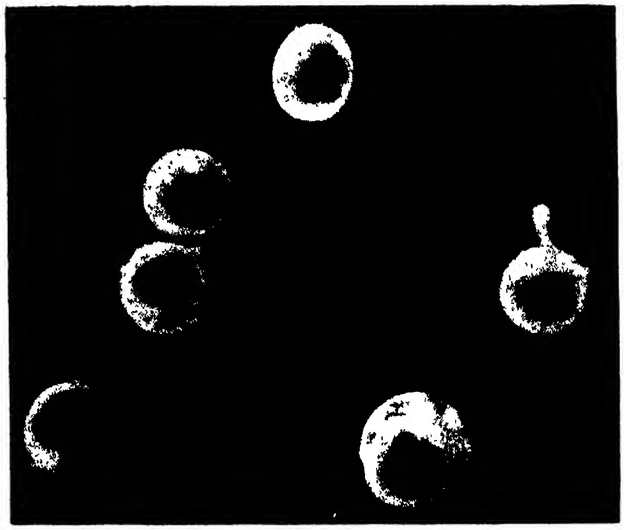
Martin Dunc

STRANGE LIFE STORY OF THE BARNACLE AS IT DEVELOPS

At the first the new hatched barnacle swims near the surface and then passes into a second larval stage in which it develops a shell a five pairs of legs, which it uses for swimming. It seeks and finds some rock or other solid object, and to this fastens itself. Gradual the entire head becomes firmly fastened and the long stalk is developed. These photographs show (bottom left) a ship's barnacle c open to expose the internal organs; a group of acorn barnacles that live on rocks (bottom right), and (top) the early stages of the barnacle's lif



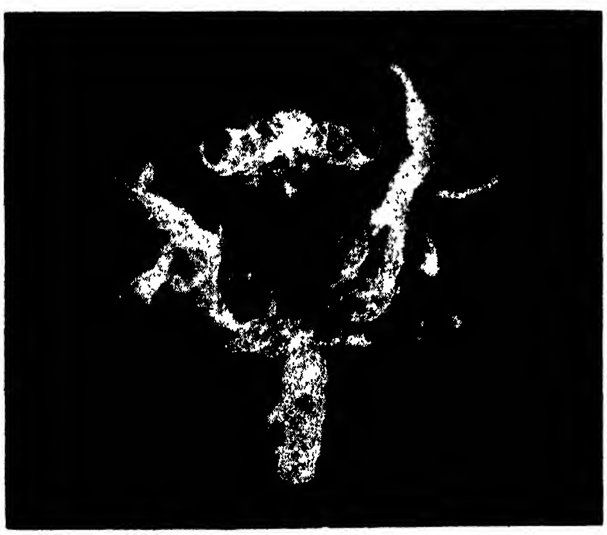
Eggs of the crab



Larvae hatching from the eggs

The larvae just emerged

Early larval stage

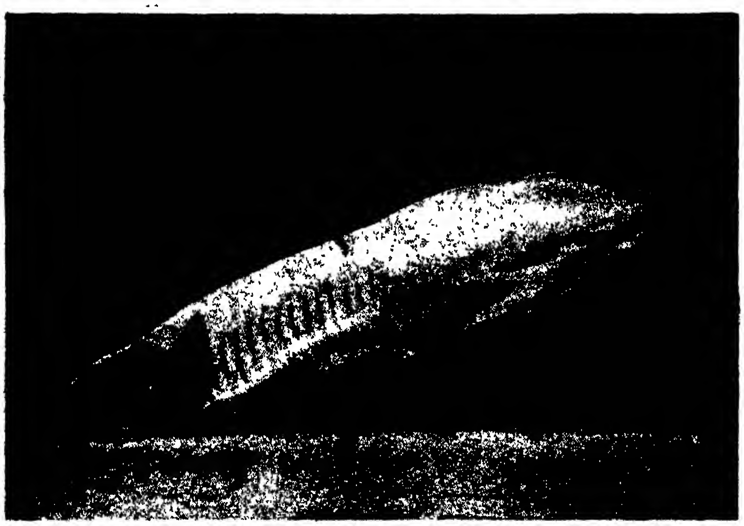


The final larval stage

Adult velvet fiddle crab

METAMORPHOSIS OF THE CRAB FROM LARVA TO FULL GROWTH

The shape of crabs does not differ between species and species nearly so much as does the form of each larva from that of its parent. Here we have the life-history of a velvet fiddler crab from egg to adult. The top left-hand photograph shows a crab's eggs just after fertilisation. When the eggs hatch (top right) weird shrimp-like creatures appear and swim actively about. This little larva gradually grows and develops till it passes through a lobster-like phase until finally the change is complete Photos by F. M. Duncan.



AXOLOTL, A CREATURE OF MYSTERIOUS TRANSFORMATION

One of the most remarkable transformations in all Nature is that of the axolotl which lives in Mexico. Here we see an advanced stage (bottom) in the changing from a water creature to a land creature. The centre photograph shows a white variety and above it is a normally tinted specimen. (See also p. 487, upper photograph.)

The familiar flat fishes, including sole, plaice, turbot, halibut, and so forth, undergo remarkable changes in early life to fit them for life on the sea floor. They must not be confused with the skates and rays, which are related to the sharks and flattened from above downwards, the mouth being on the pale under side. But in the sole and its kindred the flat sides are not upper and lower, but right and left. The side which faces upwards, towards the light, is dark in colour, while the other side is white. It is a good example of protective coloration for, when the fish remains at rest, the hues and markings of the turned-up side harmonise perfectly with the surroundings. In turbot and brill the right side of the body is white, while the opposite is true for sole, plaice, and halibut. In other words, a turbot lies down on its right side and a sole on its left. In the former both eyes are on the left side, while in the latter they are seen to be on the right side.

HE life-history of the plaice will show us how this curious modification has come about. It hatches out from the floating egg as a larva not unlike the alevin of the salmon, and the eyes are in the normal position. The little creature swims about for some time in the ordinary way, but gradually becomes flattened from side to side, and begins to tilt over to the left. Later on the right side becomes pigmented and the left eye moves round the edge of the head to join its fellow. The meaning of this remarkable movement is obvious. As the adult plaice spends most of its life on the sea floor hunting for food, with the pale left side turned downwards, an eye on that side would be useless, or worse, for it would be particularly liable to injury. Hence the transfer to the side which faces upwards.

The sea squirts, or ascidians (from the Greek, *askŏs*, a wine-skin), marine animals little known except to professional naturalists, undergo extraordinary transformations in the course of their life-history, and their place in the animal kingdom remained obscure until this had been studied. One of the simplest kinds, common on our shores, resembles in shape one of the skin receptacles in which the old easterns kept their wine, and which are alluded to in the parable about new wine in old bottles. It is fixed to some firm object by one end.

and there are two holes at the other end, while the body is covered by a tough protective coat or tunic, owing to which these creatures are often known as tunicates. Currents of sea water, bearing food and oxygen, flow into one of the two apertures mentioned, while products of waste are ejected from the other. When touched they contract and give out a jet of water, hence the name " sea squirt."

Whether these belong to the backboned animals (Vertebrata) or backboneless ones (Invertebrata) was long debated. The former possess, in some stage of their lives, three essential characters: (1) a backbone or its equivalent, (2) a tubular central nervous system (brain and spinal cord) situated near the upper surface, and (3) gill-slits, or perforations in the sides of the throat having to do with breathing. The adult sea squirt possesses only the third of these characters, making it at the best a very doubtful vertebrate, but it hatches out as a larva resembling a minute tadpole and possessing all three characters. After swimming about for a short time the larva attaches itself by means of a number of suckers on its head to some firm object, sheds its tail, and gradually takes on the adult form. It may, therefore, be regarded as a degenerate vertebrate.

The Crustacea, which include crabs, lobsters, prawns, shrimps, and a host of other forms, often undergo striking transformations in the course of their life-histories, as in the case of the edible crab (*Cancer pagurus*). This familiar creature is one of the highest members of its class, and is greatly specialised in adaptation to its mode of life, which is that of a creeping sea scavenger. Its remote relative the lobster possesses a powerful jointed tail, by the alternate bending and straightening of which it is able to swim backwards with great rapidity. But in a crab the tail is not a swimming organ and has dwindled to an insignificant appendage tucked up out of danger on the under side of the very broad body, which is invested by powerful armour. The crab hatches out as a " zoæa " larva, with a respectable though limbless tail, staring eyes, and large " foot jaws " which are employed as paddles. This minute creature gradually increases in size, grows a couple of balancing spines at its front end, and

Mondiale

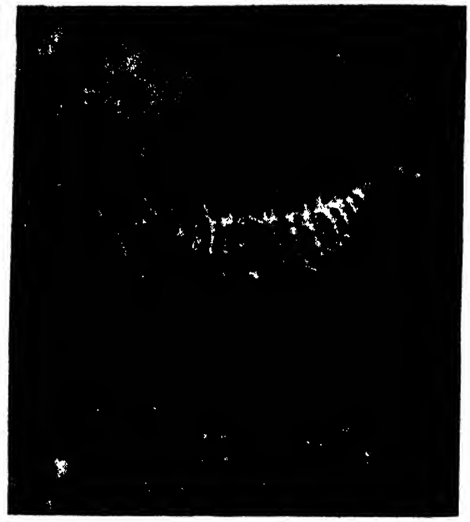
W. S. Berridge

DOG FISH AND THE CASE WHENCE IT CAME

In the lower photograph is a handsome specimen of the spotted dog fish. Dog fish start life in a kind of case which contains the eggs laid by their parents. The upper photograph shows some of these cases and where the sunlight catches them through the water it can be seen that they are almost transparent.

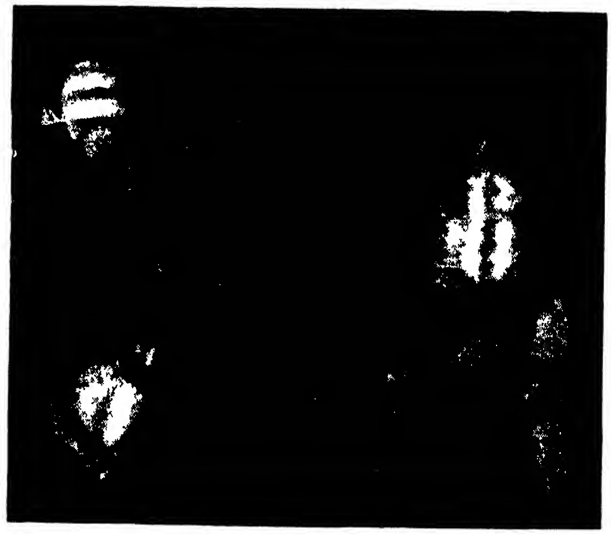
Lacewing fly's stalked eggs

Egg magnified



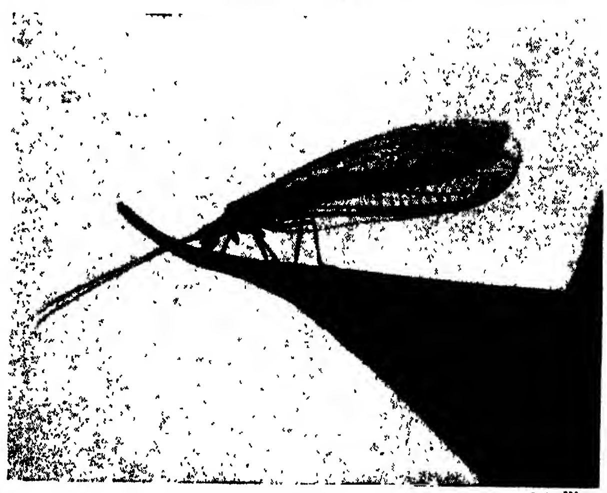
Larva magnified

Larva carrying skins of its aphid victims



Silky cocoons of lacewing fly

Lacewing fly enlarged



Side view of lacewing fly, enlarged

J. J. Ward

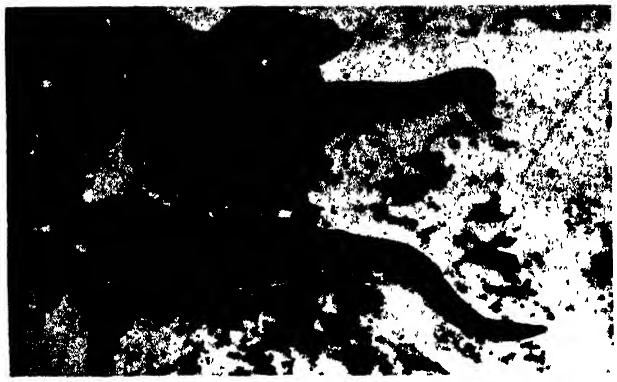
FIERCE DESTROYER OF APHIDS THAT TURNS INTO A FLY

The microscope shows us some strange things, that look like hairs with the roots attached, to be the eggs of a lacewing fly (top left and top centre). From these emerge fierce-looking creatures with a tremendous appetite for greenfly. Above (centre left) we see one whose back is covered by the bodies of its victims. This creature eventually spins a cocoon, perhaps, as seen above (centre right), attached to bramble leaves, and emerges from its pupa case a perfect lacewing fly as shown in the bottom photographs (magnified).

Eggs of smooth newt with tadpoles inside

Young newts soon after hatching

Tadpole stage of newt showing gills



Smooth newt leaving water for terrestrial life

Newt depositing an egg which it folds in a leaf

Male and female smooth newts

CYCLE OF A NEWT'S EXISTENCE FROM WATER TO LAND AND BACK AGAIN

Newts, save in the breeding season (bottom right), are creatures of the land. The eggs are laid among the water-weeds, a leaf being folded (bottom left) to form a case. The eggs (top left) devolop in a transparent envelope. When the eggs hatch the tadpole with feathery gills appears, breathing oxygen through the water. When development is complete and the gills have shrunk to be displaced by lungs, the newt leaves the water to live on land until the breeding season calls it back to water again. Photos by J. J. Ward.

YOUNG RED DEER WITH SPOTTED COAT

In the world of backboned animals there is no startling change from one sort of creature to another, no metamorphosis so extraordinary that it would seem hardly possible for the last stage of the animal to have anything to do with the first. But there are changes of a minor sort, and these have a meaning. Compare this young deer with the adult in page 721.

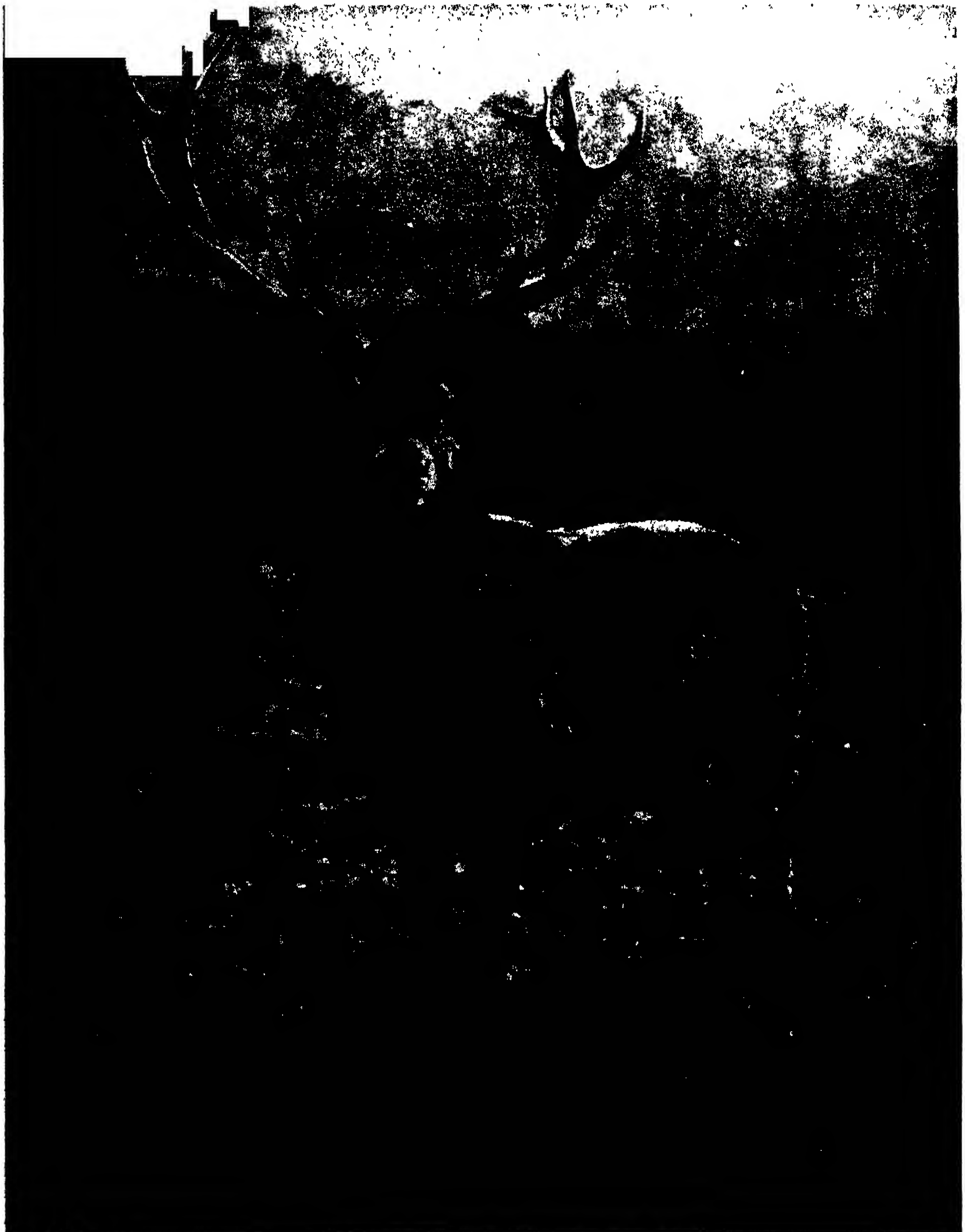
acquires the full complement of limbs. Later on it passes into the lobster-like "megalopa" stage, which suggests that the remote ancestors of crabs were long-tailed animals, finally taking to a crawling life and acquiring the characters of the adult.

It may be mentioned here that the floating population of the sea, or plankton, includes a great many transparent larvae of all sorts and kinds, and it is probable that many marine animals have developed a larval stage in their life-history to facilitate distribution, by enabling them to settle down here and there in suitable places.

A crab is sometimes to be found with a round swelling on the under side of its tail, and dissection proves this to be a parasitic animal that extracts the juices from the unfortunate "host"—as the prey of a parasite is ironically called—by means of branching root-like threads. This parasite (*Sacculina*) is little more than a bag of eggs, which hatch out into larvae resembling those of the barnacles, undoubted Crustacea in spite of their appearance when adult, so that here we have to do with a sort of barnacle that has taken to a parasitic life and degenerated in consequence.

Among shellfish (Mollusca), sea snails and bivalves hatch out as minute free-swimming larvae extremely unlike the adults in appearance. We may take the oyster as an interesting case. It would hardly be suspected that this highly respectable but somewhat stolid animal had led an active life in its youth, yet this is the truth. It hatches out as an extremely small larva with a fringed flap on its head. The fringe consists of delicate living threads (cilia) which alternately bend and straighten, thus rowing the little creature about. The two valves of the shell develop on the right and left sides of the body. Later on, as "spawn" or "spat," the young oysters sink down to the sea floor and settle for life. Each of them lies down on its left side and becomes attached to some firm object by the left valve of the shell, this becoming concave for the reception of the body. The right valve remains flat and acts as a sort of lid The life-history of a fresh-water mussel (*Unio*, or *Anodonta*) presents several points of interest. There are two long flat gills, inner and outer, on each side of the body, and during the spawning season the outer ones become very much thickened, owing to the presence of innumerable developing larvae. Were these tiny creatures simply discharged into the surrounding water they would be carried away by the current, ultimately to perish in the sea. Such a fate is obviated by conversion of the outer gills into incubators, by means of which wonderful device the larvae do not escape until they are fully formed.

Each of them is then known as a glochidium, and is quite unlike the adult in appearance. It swims by



Autotype

ADULT RED DEER WHICH HAS LOST THE SPOTS OF ITS YOUTH

It is a very common thing amongst the higher animals for the young to differ from their parents in their exterior appearance. This difference takes the form of a striking variation in the markings and, in this case, we notice that while the young red deer, seen in the opposite page, has a spotted coat, its parent's coat is plain. This has suggested that, since the young animal is believed to recapitulate the story of the evolving of its particular species, the ancestors of the red deer were once spotted throughout their lives.

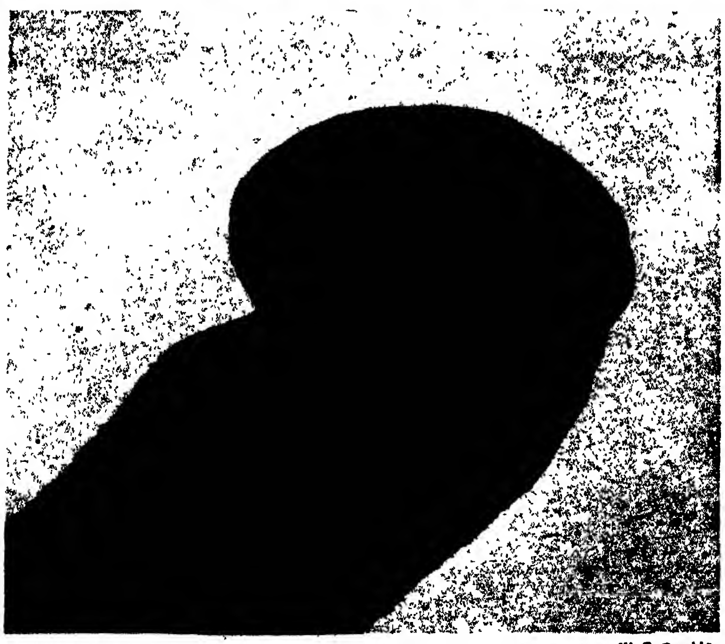
W. S. Pitt

CHANGES OF FORM WROUGHT BY MAN'S INTERVENTION

For centuries both the Chinese and the Japanese have been breeding goldfish, as is proved by their representation in old tapestries. More brightly or variously coloured specimens were sought for and changes of form were even brought about. The lower photograph shows a scaleless variety of the fantail goldfish, while above is a scaled fantail fish which, like all but the scaleless goldfish, starts life a bronze colour and becomes gold in a few months. The elaboration of fin, artificially wrought, is extraordinary

FREAK TRANSFORMATIONS IN FOWL AND LIZARD

Among domestic fowls it is not uncommon for individuals to change their sex. Here is an example of a so-called "hen-cock" which, starting life as a hen, began to assume the plumage and comb of a cock. This is one of Nature's strangest mysteries. The upper photograph shows a specimen of the eyed lizard of Southern Europe. Having discarded its original tail, this one achieved the growth of two new ones, through some mysterious increase of virtue in the power which lizards have of reproducing lost tails



W. S. Berridge

ADULT AND YOUNG OF BLADDER-NOSED SEAL

Fiercest and most courageous of the seals of the Arctic Seas is the hooded or bladder-nosed seal, so called because of the remarkable bag of skin covering the nostrils of adult males. But the young, as we see here (top), are entirely without this distinguishing mark. The bag can be inflated with air.

alternately opening and closing the shell, and a long sticky thread growing from the under side of its body trails behind in the water. This holds fast should it come into contact with a stickleback or other small fish. The larva then grips the victim with its shell, each valve of which possesses a sharply bent hook. The irritated skin of the fish grows round the attached larva, forming a sort of gall. Here the glochidium is gradually transformed into a little mussel, the gall is ruptured by its growth, and it eventually falls down into the mud at the bottom, there to live for the rest of its life.

Hedgehog-skinned animals (Echinoderms), including starfishes, brittle stars, sea urchins, and sea cucumbers, usually hatch out as curious larvae which swim by the action of bands of cilia. That of a brittle star or sea urchin is called a pluteus, and looks something like a painter's easel turned upside down. The "legs," more numerous than in any easel, are strengthened by delicate calcareous rods. A series of complicated changes follow by which the adult form is ultimately attained.

The Gamut of Sound in the Insect World

By L. C. Bushby

Curator of Insects, London Zoological Gardens

Sounds as well as scenes add to the enjoyment of a walk through woods and fields on a summer day or in the gloaming. There are the cries of animals, the songs and calls of birds, the sounds made by insects, and it is these last that to some minds have the greatest interest, inasmuch as close observation is needed to determine, first their origin and then the how and the why of both their mechanism and meaning.

Since the time when insects first began to be studied intimately by the old naturalists considerable attention has been paid to these problems and much knowledge has been gained on the subject; but, undoubtedly, further mysteries remain to be unravelled by dint of patient research.

Insects do not possess what can be termed a true voice; but many of them are able to produce by various methods sounds of one kind and another. All the main orders into which insects are divided contain species that have this power of sound production and it follows that as they differ in structure so they must of necessity employ different methods for the creation of their specific sounds.

The great majority of insect sounds are produced by the method known as stridulation, that is, the friction of one part of the body against another. The order Orthoptera, that contains, among other creatures, the grasshoppers, locusts and crickets, must be given first place in possessing the greatest number of expert exponents of stridulation. Who has not heard the monotonous chirping of the cricket and the more subdued rasping of the various grasshoppers? How are these sounds produced? Taking first the case of the crickets we find on investigation that it is from the wing-covers, or tegmina, that the sounds emanate. The tegmina are really modified fore-wings, and where they overlap each other at the base are provided, one with a finely-toothed area, and the other with a hardened process acting as a scraper. With a slight raising and lowering of the tegmina these two instruments are brought into contact with one another, producing a chirping sound that varies in shrillness according to species. There is in Africa a large cricket, *Brachytrypes membranaceus*, that constructs long burrows in the soil and at night sits at the mouth of the main burrow playing on its instrument. The noise it produces is exceedingly shrill and piercing, and can be heard nearly a mile away. It is a very vibrant note, filling the air to such an extent that should one be quite near a cricket when it ceases to stridulate the sudden silence affects the ear in a most amazing way.

In the Locustidae, a family containing the long-horned grasshoppers, it is again the overlapping bases of the fore-wings that carry the musical instruments and are capable of emitting some very quaint sounds, some of which are not unpleasing except, perhaps, in their monotony. The Katydids of North America, of which there are several species, are much noted for and, indeed, have gained their name by, the very quaint noise they make at nightfall. It sounds very like "Katy did, she did!"

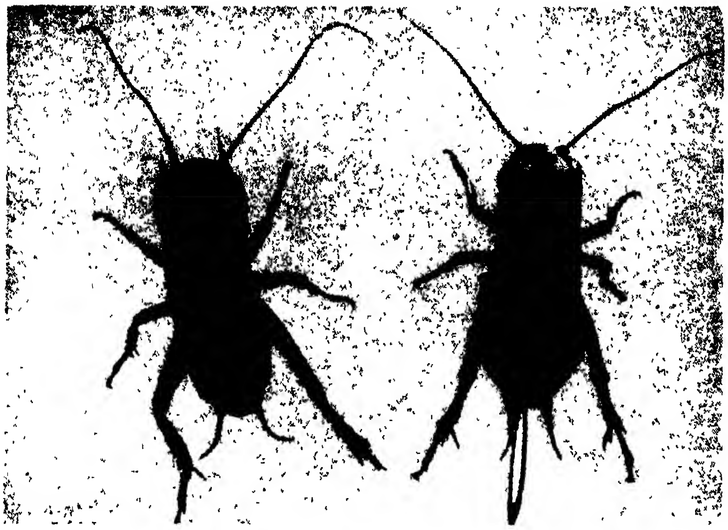
The true grasshoppers and the locusts (*Acridiidae*) use a somewhat different form of instrument. The inner side of a portion of each hind leg is furnished with a row of fine teeth, and when these are rubbed up and down a raised and hardened vein on the fore-wings a rasping noise is produced. The sounds made by these insects are usually not so loud as those made by the crickets and long-horned grasshoppers, and may be heard during the day. A few grasshoppers can stridulate while in flight and effect this by the friction of the hardened upper surface of the costa, or front margin, of the hind wings and the thickened veins on the underside of the fore-wings, the legs not being used at all.

J. Ward

MUSICAL WINGS

Below is a humble-bee (worker) whose droning is so familiar a sound of summer-time. Above we have a bee-hawk moth which sips nectar while hovering on loud-humming wings.

Several species of beetles (Coleoptera) make sounds in a variety of ways, and in most cases it is the file and scraper system that is employed. In some species the instrument is contained in the thoracic segments, the pronotum rubbing against the mesonotum; or it may be that friction is set up between rasps on the wing-cases, or elytra, and ridges on the abdomen, or between folds in the wings and abdominal ridges. Some species of beetle larvae stridulate, and in the majority of instances some part of the legs are used for the purpose. The larva of Passalus has the third pair of legs especially

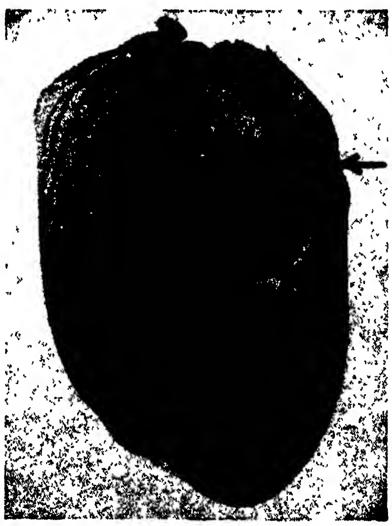


Field crickets, male and female

Stridulating bow from above

Side view of bow or file

Ear in foreleg



Bow on wing marked by arrow

CRICKETS AND HOW THEY CHIRRUP

Below are (left) the orifice of the cricket's "ear" which is situated just below the "knee" of the fore-leg: and (right) the fore wing-cover of a male field cricket showing the file-like ridge or "bow" which is scraped on a vein of the wing beneath. The centre photographs give a general view of the "bow." The photographs are by H. Bastin.

modified and they are apparently used only for sound production. Many of the Scarabaeid larvae, while their legs are not so greatly modified, are able to emit squeaking sounds.

Certain butterflies and moths are capable of stridulation. The death's-head hawk-moth and other members of the same genus, *Acherontia*, emit a squeaking sound that is considered to be caused by air being forced through the proboscis and not actually by stridulation. It is said that the imago can sometimes be heard squeaking before it leaves the pupal case. The larvae of these moths can also make themselves heard; but in a different way; it is the mandibles vibrating sharply on each other that produce a sort of crackling sound. Clicking noises are made by a South American butterfly, *Angeronia*, when in flight, and are caused by a stridulating apparatus at the base of the fore-wings where there is a ridged and thickened area.

E are some species of ants possessing stridulating organs of one kind and another, although the sounds produced are in some cases not very audible. *Mutilla*, a species of parasitic wasp, can stridulate in much the same way as do the ants.

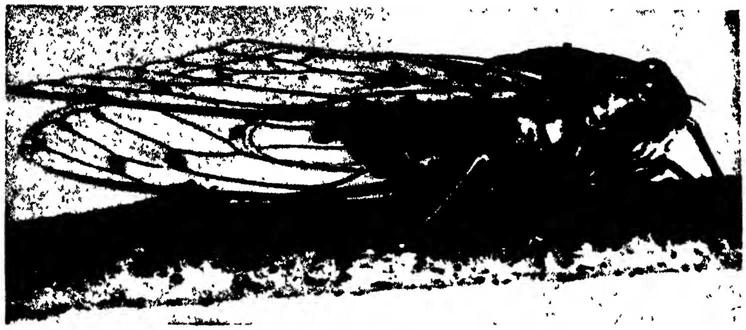
Wing-vibration plays a considerable part in the production of sound among insects and we have familiar examples of this in the bees, wasps, flies and certain beetles. The droning hum of the cockchafers or may-bugs (*Melolontha*) and the dor beetles (*Geotrupes*) as they fly at dusk is surely known to most people. The various bees and flies give out sounds of definite tone according to the rapidity of the wing-vibration, and the fact has been established that the wings of the honey-bee vibrate at the rate of 440 times in a second and produce the note A, while those of the house-fly vibrate at 335 and produce the note F. Some interesting experiments relating to wing-vibrations of bees and flies were carried out by Marey, who, with the aid of a revolving cylinder so arranged that it was just touched by the extremity of an insect's wing, was able to prove by the marks recorded on the cylinder that the strokes per second agreed very closely with the figures quoted.

How is it that a fly will buzz when held by the wings?. It is the insect's breathing apparatus that enables it to

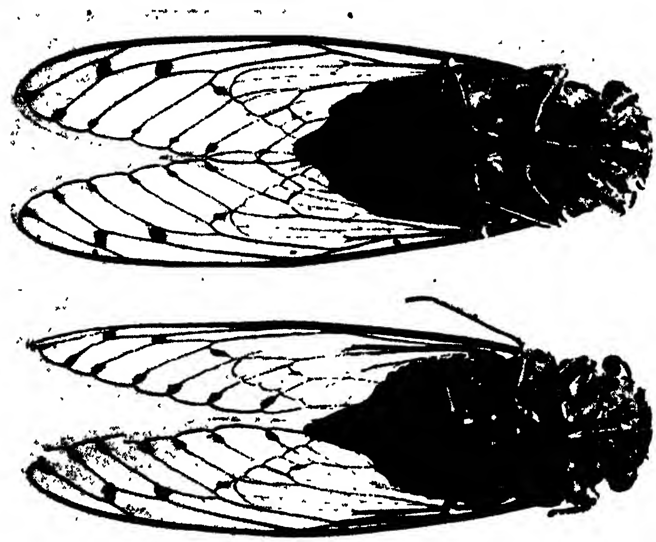
protest so audibly. There is behind each of the thoracic spiracles a membraneous projection which vibrates during respiration and so causes the " voice." The sounds produced in this way differ in tone from those produced by wing-vibration and are usually higher in the scale. Bees and various diptera such as mosquitoes and hover-flies are all able to buzz without the aid of their wings. Most people will agree that the humming of a bee as it goes about its business in the garden is quite a pleasing sound, while a blowfly buzzing round a room only irritates. Why should this be so? It may be because of the actual difference in tone and, in the case of the blowfly, the jerkiness of it, or it may be that we associate the bee with pleasant things, flowers, honey, etc., and knowing the fly to be an intruder and a spoiler of our food we instinctively dislike his voice.

The star songsters of the insect world are undoubtedly the cicadas. These insects occur in many parts of the world, the majority being found in tropical regions. They belong to the order Hemiptera and are provided with a proboscis with which they suck the juices of plants. They vary in size, some being less than an inch long and others robust creatures of three inches and more. There is one British species, but it is very local, living only in the New Forest.

Unlike small boys, who are supposed to be seen and not heard, cicadas are far more often heard than seen. Many of them frequent the high branches of trees in tropical forests, and it is only on hearing their loud, persistent notes that one is aware of their presence. The cicada does not stridulate; but possesses a vibrating instrument controlled by muscular action. This sound organ, the most highly specialised of any contained in insects, is situated at the base of the abdomen. It consists of a pair of drums, somewhat shell-like in shape. The membrane of these drums is in each case operated upon by a special muscle attached to the inner surface, causing them to vibrate and emit an intense shrilling sound. Two other membraneous areas, one of them known as the mirror, are situated near each drum and act as sounding boards, intensifying the sound. Only the males possess this remarkable apparatus, the



Side view of male cicada



Undersides of male and female cicadas

Drum of

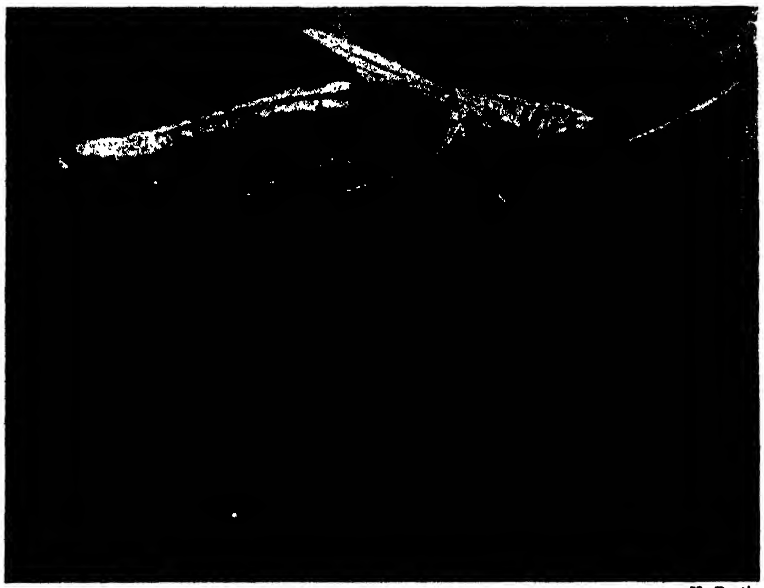
CHAMPION INSECT MUSIC MAKERS

Of all the insect " songsters " the cicada is the chief. Its sound organ or " drum " is the most highly-specialised apparatus of its kind in the insect world. The bottom photograph shows the drum at the base of the abdomen in the male. The top illustration shows a male on a twig The photographs are by H. Bastin

spectively of the serenader and the serenaded, for it is in the hope of attracting to himself the desired female that the cricket or the grasshopper performs his very best on his instrument. In the few instances where both sexes of grasshoppers possess stridulating organs, the female answers the male when he calls, her note frequently differing slightly from his.

The time most usually chosen for tuning up is at dusk or during the night; but quite a number of insects stridulate or hum during the sunny hours of the day, and it is reasonable to suppose that the sounds are then emitted for no other reason than mere enjoyment of life. In most species of stridulating beetles an equality of the sexes is the rule, the females being able to "answer back." There is an exception to this in the case of a Bostrichid beetle (*Phanopate*) of which the female has all the say and the male has to remain silent.

Death-watch beetles tap messages to one another through intervening pieces of timber, and appear to have established a definite code, for the series of taps they make always has the same rhythm. Fear or alarm is undoubtedly expressed by certain insects when they utilise their sound organs; certain beetles



H. Bastin

GRASSHOPPER AND THE "FLYING GOOSEBERRY"

This young short-horned grasshopper (magnified) has its "ear" just below its wing-cover. Above is a species of locust called the "flying gooseberry," whose body is almost hollow and forms a resonator or sounding box when the insect rubs its hind-legs over certain ridges in its abdomen. The vital organs are in a very small area.

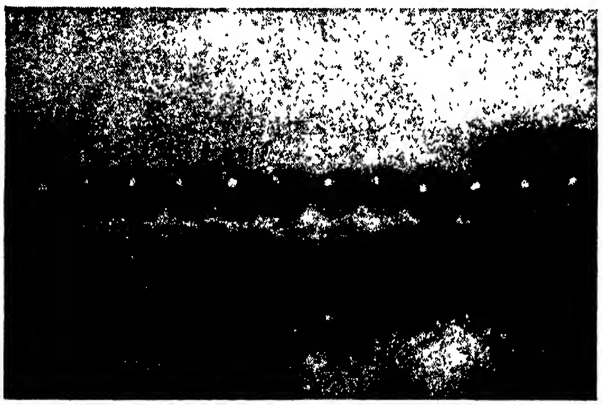
females having, willy-nilly, to be silent. One other method of sound production must be mentioned. Its users require no specialised apparatus, but simply tap with some part of the body upon the surface on which they happen to be resting. Some beetles do this. A classic example is the death-watch beetle (*Xestobium rufovillosum*), a species that has gained much notoriety by damaging to a great extent the roof-timbers of old and famous buildings. Both sexes "call" by striking the wood on which they are standing with the lower part of the front of the head, the result being a series of distinct taps. Other insects that have this habit of tapping are certain species of termites, or white ants, as they are sometimes called, and it is the soldiers that perform by striking the flooring of their nest with the head.

The natives of South Africa have given the name of "toktokkies" to certain Tenebrionid beetles that have the curious habit of raising the somewhat pointed end of the abdomen and letting it fall sharply, two or three times a second, on to the floor, thus producing a series of jarring taps.

Why do insects make sounds? There must be some meaning attached to the fact that grasshoppers chirp and beetles squeak. Observations, both in the field and in the laboratory, have shown that there is in many cases definite reason for these audible outbursts. More often than not it is the males only that stridulate or in other ways declaim. This is the case with most of the long- and short-horned grasshoppers and the crickets. The male "sings," but the female is mute. They take the parts re-

for instance, protest squeakingly when held or trapped in some way, and it is quite possible that the sudden, unexpected cry frightens their captors into dropping their prey so that it has a chance of escape. The death's-head hawk-moth is looked upon as a most uncanny creature by some people; the fact of its power of squeaking and having on its back marks resembling a skull and cross-bones have given rise to superstitions regarding it. It is believed that some insects sound the call of alarm on the approach of danger to warn others of the species. An excellent instance of this is known to occur in the nests of certain species of termites when a large number of the soldiers collect together and all tap the floor of the nest with their heads, maintaining some

H. Bastin



SHORT-HORNED GRASSHOPPER AND ITS "BOW"
Magnification shows this creature's methods of producing sounds. Below is the ridge running along the thick or thigh part of the hind leg, and which is used as a bow to rub against a vein on the wing cover. Above is a general view of the whole leg.

sort of rhythm apparently, while thus engaged. Some insects are able to perceive sounds. If this were not so sound production in these species would have no meaning. What kind of "ears" do insects possess? The grasshoppers and crickets, being the best musicians of the insect world, are provided with the most highly specialised form of auditory organs, and investigation has revealed the fact that these organs are situated either on the first pair of legs or on the abdomen.

IT is in the Acridiidae, the short-horned grasshoppers, that the "ears" are carried on the abdomen. There is on each side of the base of the abdomen a membranous area surrounded by a horny ring. This membrane, or tympanum, vibrates to certain sound waves and the vibrations are then transmitted to a nerve centre by means of specialised processes behind the tympanum. Many of the long-horned grasshoppers have "ears" on their fore-legs, a pair of auditory organs of a somewhat similar nature to those which have just been described being situated on each tibia. Crickets, also, hear with their fore-legs.

Can the humming of the female mosquito be heard by the male? The male mosquito is provided with beautifully plumed antennae and it is through the medium of these ornaments that he is able to perceive certain sounds. By experiment it has been found that some of the hairs respond to the vibrations of a tuning fork and that the vibrations are conveyed to the nerve centres by extremely delicate internal contrivances. In several other kinds of insects the organ of hearing is situated in the antennae. Some ants and bees, as well as the gnat-like flies (*Chironomidæ*) are able to hear thus and can be guided by sound to their waiting mates.

BESIDES the forms of auditory organs already mentioned there are others more or less specialised, some in the body-wall of the insect and others in the tibiae or tarsi of the legs.

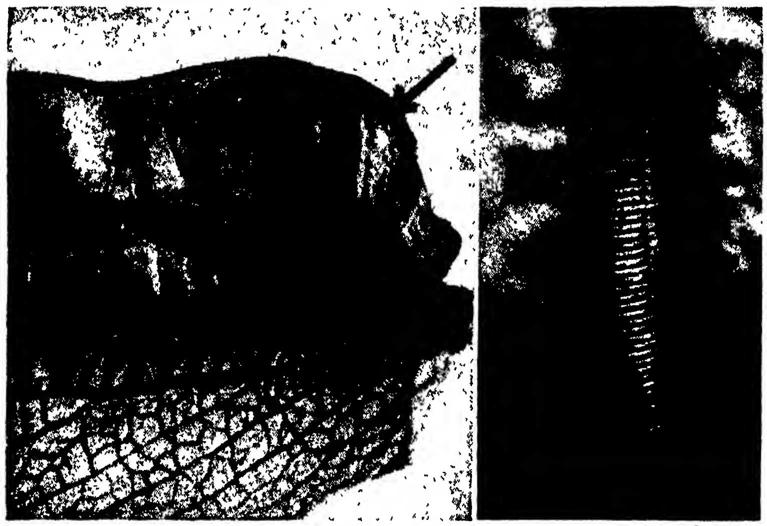
Hearing is evidently not confined to the adult insects. In the larvae of some insects such as hover-flies, saw-flies, gad-flies, cockchafers, etc., there have been found, sometimes in the abdominal wall and sometimes on the legs, certain simplified but very interesting forms of auditory organs.

In this country we have a good many insects that make sounds of one kind or another. We hear the grasshoppers and the crickets reiterating their shrilling or chirping calls. In the flower-bedecked meadows and along the hedgerows we note with pleasure the humming of the bees as they go to and from the attractive blossoms. The vicinity of a lime tree in full bloom is most delightfully suggestive of some fairy concert hall

At dusk during the early summer we may hear the deep, droning hum of the may-bugs or perhaps a clumsy, heavily-flying dor beetle will pass just over our heads, sounding, as he approaches and disappears, like an aeroplane in miniature.

and some species create sounds that quaintly resemble certain words. The Katydids, of which mention has been already made, are celebrated for this. There are several species in North America and a few have gained great renown. The noise of a Brazilian insect, a long-horned grasshopper, is said to be very remarkable, a loud, resonant "ta-na-na, ta-na-na" being stridulated by the creature.

Tropical crickets are, many of them, very noisy, and it is difficult to believe that the extremely loud cries that some of the largest species make emanate from a mere insect. As with some of the cicadas, so certain of the crickets were, and still are, prized on account of their song. The Japanese confine them in little cages so that they may enjoy the music.



H. Bastin

STRIDULATING VEINS OF THE GRASSHOPPERS

These magnified photographs show (bottom left) the wing case of a large green grasshopper with the stridulating or grating vein, marked by an arrow, on which the insect rubs its legs to produce the chirrup; (bottom right) detail of the vein of a long-horned grasshopper and (top) the "ear" in the leg of a short-horned grasshopper.

The sounds produced by British native insects are for the most part pleasing, especially when heard out of doors. We dislike the blue-bottle fly or the mosquito when they intrude into our houses and buzz in a very irritating fashion round the room or hum close to our ear as we lie in bed. But our insect musicians are few in numbers and weak in tone compared to those of tropical and sub-tropical countries. In practically all the books that have been written on the natural history of various tropical regions reference has been made to the predominance of insect sounds. In many cases the sounds have been described as being the very opposite of pleasant. The shrillness and monotony of some insect cries are said to be absolutely wearing to the nerves.

It has been said previously that the cicadas are particularly noted for their musical powers. Travellers in jungle regions are often an unwilling audience at a cicada concert. Bates, in his book "A Naturalist on the Amazons," describes one of these concerts and says that the notes emitted were not only piercing and jarring at the start, but got shriller until they resembled nothing so much as a steam engine's whistle. It can well be imagined that the cicada can make itself heard a considerable distance away. Some of the lesser cicadas have more pleasing voices and, indeed, it is said that the ancient Greeks were in the habit of keeping specimens of a certain European species in cages so that they might appreciate their singing at leisure.

Many of the tropical grasshoppers and crickets have voices too loud and harsh to be pleasant and in others it is not so much the intensity as the monotony of the sound that irritates. There are some species, however, that are more or less pleasing to listen to.

It is unfortunate that the majority of the tropical insects choose the early part of the night in which to give vent to their vocal powers. Did they but perform during the sunny hours of the day they would doubtless be much more appreciated by the people who reside in or travel through the warmer climes and who are kept awake by the insects' chorus mingled with the cries of birds and monkeys.

It will be realized from what has been described in the foregoing that the main reason for sound production among insects is the mating impulse. Some insects, it is true, sing for no apparent reason; but with the majority it is a case of the male lifting up his voice in praise of, or in ardent appeal to, his loved one and she listening mutely or possibly intimating in faint tones that—she will.

Chapter LXVIII

Mammals That Live in the Sea

By R. J. Daniel

Lecturer in Oceanography, Liverpool University

It is part of our common experience that the domestic animals we see about us every day, such as the horse and the dog, differ very much from each other in appearance, but it takes a little reflection perhaps before we realize that in some important respects they are very similar to each other. They are, like ourselves, all warm blooded, they are all covered with hair, and the young are fed on milk and nursed with great affection.

Because of these general attributes such animals have been classed together as mammals, and the group shows a diversity of forms which have been successful in all parts of the world and under varying conditions of climate. So great has been this adaptability that certain of them have taken to the sea, and there they are able to prey upon such creatures as the fishes, which are themselves peculiarly fitted for life in the water, and the ancestors of which never knew any other domain.

The accommodation of certain mammals to a marine life has only come about gradually, and all have not become suited to the same degree. The carnivorous Pinnipedes, to which group the seals, the sea-lions, and the walruses belong, live mainly in the sea, but all may come ashore either upon ice or some quiet stretch of coast, and the young are never born in the water.

The second great order of marine mammals, the Cetacea, which includes the whales, have gone a step further and have taken to the sea so thoroughly that they have become totally incapacitated for any life on the land, and if they touch bottom, as may happen upon occasion, they become stranded like any ship and find themselves in a similar desperate position. The members of the whale family, in fact, have become so modified externally for dwelling in the sea that they are often wrongly referred to as fishes, a very natural error under the circumstances, and one that was made by students of Natural History for several centuries. Yet, in spite of these changes, which include the loss of practically all hair upon the body, the porpoises and whales are so much like the land mammals in general habits and internal structure that one does not hesitate in pronouncing them as being allied to this group.

The various members of the seal family themselves show degrees of liking for the water, and also represent different stages of agility when on the land. In all of them the limbs have been shaped into paddles which are peculiarly suited for aquatic locomotion, but these still possess a strong skeleton and are therefore able to assist also in land transport.

The walrus, or morse, of the polar regions is the least accommodated of this group when in the sea. While swimming it uses both its fore and hind limbs, but although powerful it is not so graceful in its movements as the other Pinnipedes. It rarely ventures out of shoal water, but moves about among the banks, seeking its under-water food, which consists mainly of clams. The male walrus, and many of the females, too, possess a pair of tusks in the upper jaw that are employed in digging for the shellfish. The very stout bristles that form the whiskers assist in this hunt and the grinding teeth crunch the clams that are procured.

W. S. Berridge

SEA-ELEPHANT OF KERGUELEN ISLAND

Sea-elephants, or elephant seals, are so called not only on account of their bulk—they are often twelve feet long—but also on account of the proboscis they possess, which rather resembles a very short trunk. Their chief home is Kerguelen Island in the south of the Indian Ocean

The walrus is very robust in appearance, this being due in part to the thick layer of blubber, or oil, that lies beneath its wrinkled skin. The animal lives a rough-and-tumble sort of life on the sea bottom or among the ice floes, so that it suffers numerous buffetings and lacerations. Many of the older ones, therefore, are scarred, and the covering of hair, which is never plentiful, is often worn away in patches. Altogether, the walrus is a tough and battered specimen, and the only member of the group that is really dangerous when hunted by man.

The eared seals, so called because they are the only Pinnipedes

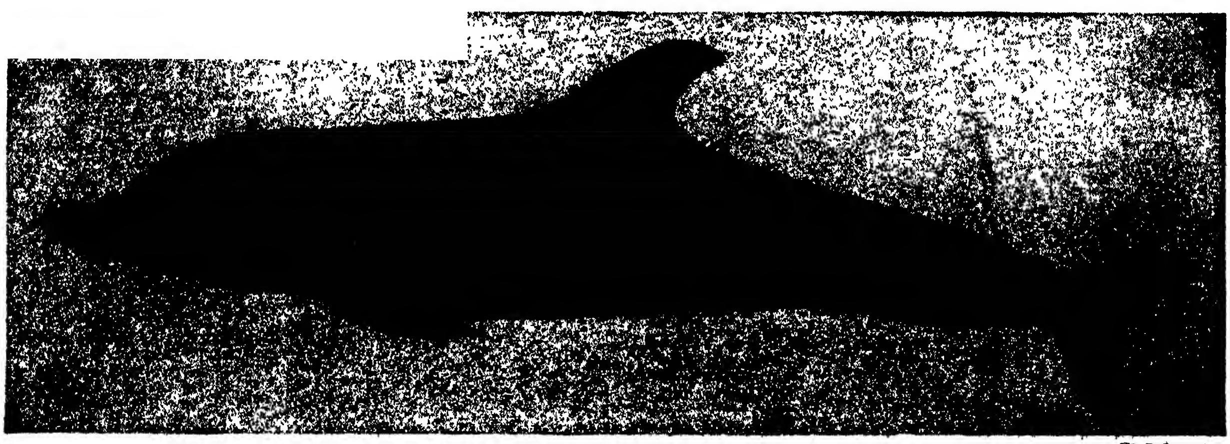
DOLPHIN FOUND ROUND THE CAPE OF GOOD HOPE

Among the smaller species of dolphin is Heavyside's dolphin, named after the man who classified it, which haunts the waters round the Cape of Good Hope. Its average length is about four feet. The rounded back and the shortness of the "beak"—this beak being a characteristic of all the dolphins—make this particular species very reminiscent of the conventional dolphin of municipal statuary. In the colouring of its skin it rather resembles the killer-whale, or grampus. (See p. 456.)

that possess small external earflaps, are excellently represented by the sea-lions of the Southern Hemisphere and the North Pacific, and the sea-bears or fur seals of Alaska and the neighbouring islands of the Bering Straits. They are much more nimble on the land than the walrus; like that beast they are able to double the hind limbs under the body, and so progress with the assistance of the fore limbs, by means of a shuffling, rocking motion that carries them along a beach almost at a man's running pace, and, in addition, allows them to clamber up rocks in an amazing fashion. In such actions the animals are assisted by the flexibility of the torso, but this suppleness is as nothing when compared with the ease and rapidity of movement that takes place in the water. From the head thrust eagerly forward to the trailing hind legs used only for steering, the animal now presents a beautiful streamline body that is urged along with prodigious speed by means of powerful strokes of the paddle-like fore limbs. The eyes, which are somewhat short-sighted when gazing through the air, are able to focus themselves perfectly under water, so that in place of a soft and docile expression the sea-lion now displays the eager glinting eyes and the flashing teeth of the true hunting carnivore. Once in the sea it has few enemies it need fear, and even the ferocious sharks keep at a distance.

Eared seals that have been subject to a good deal of observation because of the value of their furs are the sea-bears, and their mode of life may be taken as typical of the group. They range the North Pacific in herds for seven or eight months of the year, hunting mainly for squids and different kinds of octopi that are in great abundance in the ocean.

Leaving the islands that may be regarded as their homes, they strike south to temperate seas then,



W. S. Berridge

COMMON DOLPHIN SOMETIMES SEEN OFF BRITAIN'S COAST

All over the Mediterranean and in many localities of the Atlantic one may meet the common dolphin sporting among the waves and following ships. It was this habit of swimming only half submerged that led to the famous legend of Arion, the Greek musician, who rode upon the dolphin's back, having charmed the animal by his playing of the lyre. The common dolphin is some seven feet long and has a dark back and a whitish belly. There are about fifty pairs of teeth to each jaw.

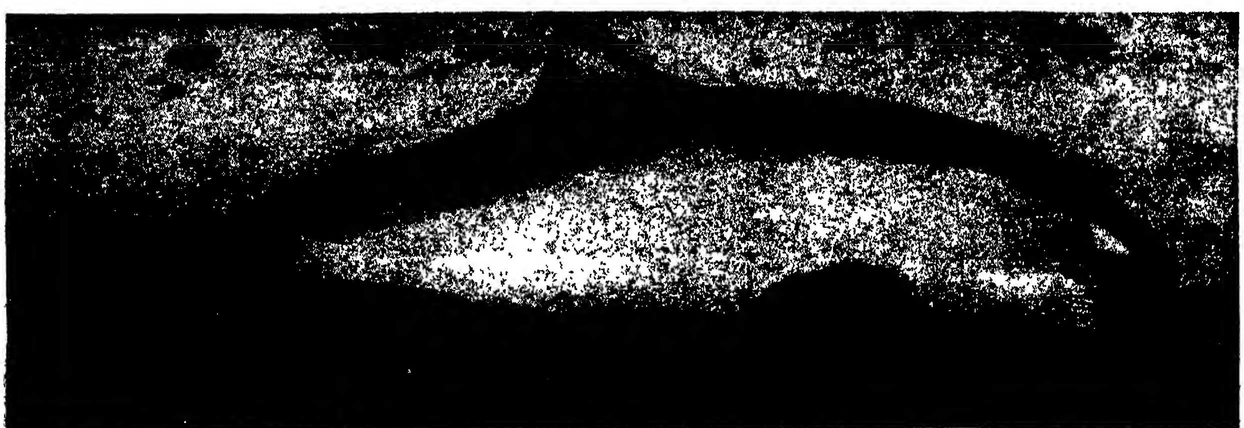
CUVIER'S WHALE WIDELY DISTRIBUTED THROUGH THE OCEANS

Belonging to the group of beaked whales in which the teeth are so vestigial that they never grow through the gum, Cuvier's whale is very widely distributed and has been found off the Shetland Islands and in the seas round New Zealand. The males of Cuvier's whale do possess two teeth but the females are toothless. These whales are less given to swimming in shoals than the dolphins and, for whales, are not very large, the average length being about nineteen or twenty feet. Their food consists for the most part of cuttlefish.

turning in towards the Californian coast, travel north again and return by a different route. During this lengthy course they thrive prodigiously, and so in the spring they approach the islands again in splendid condition. The adult males or "bulls" land first, and then follow the younger males and the females. The beaches are now swarming with them, and the reason for deserting the sea which has served them so well becomes apparent, for each mature female soon gives birth to a young one.

In spite of the noise and apparent confusion in these "rookeries," very definite social distinctions are drawn. Each of the older and stronger males gathers about himself a varying number of females and keeps jealous guard over them. There is a good deal of struggling and fighting, so that the younger males are cast out from these family arrangements and, deserting the rookery, they form a separate bachelor colony of their own. The young "pups," which are rather helpless at first, show no desire to enter the water, and are suckled by the mother. It is necessary for the latter, however, to hunt for food constantly, and so she takes to the sea again, and may leave the pup to its own devices for one or two days at a stretch.

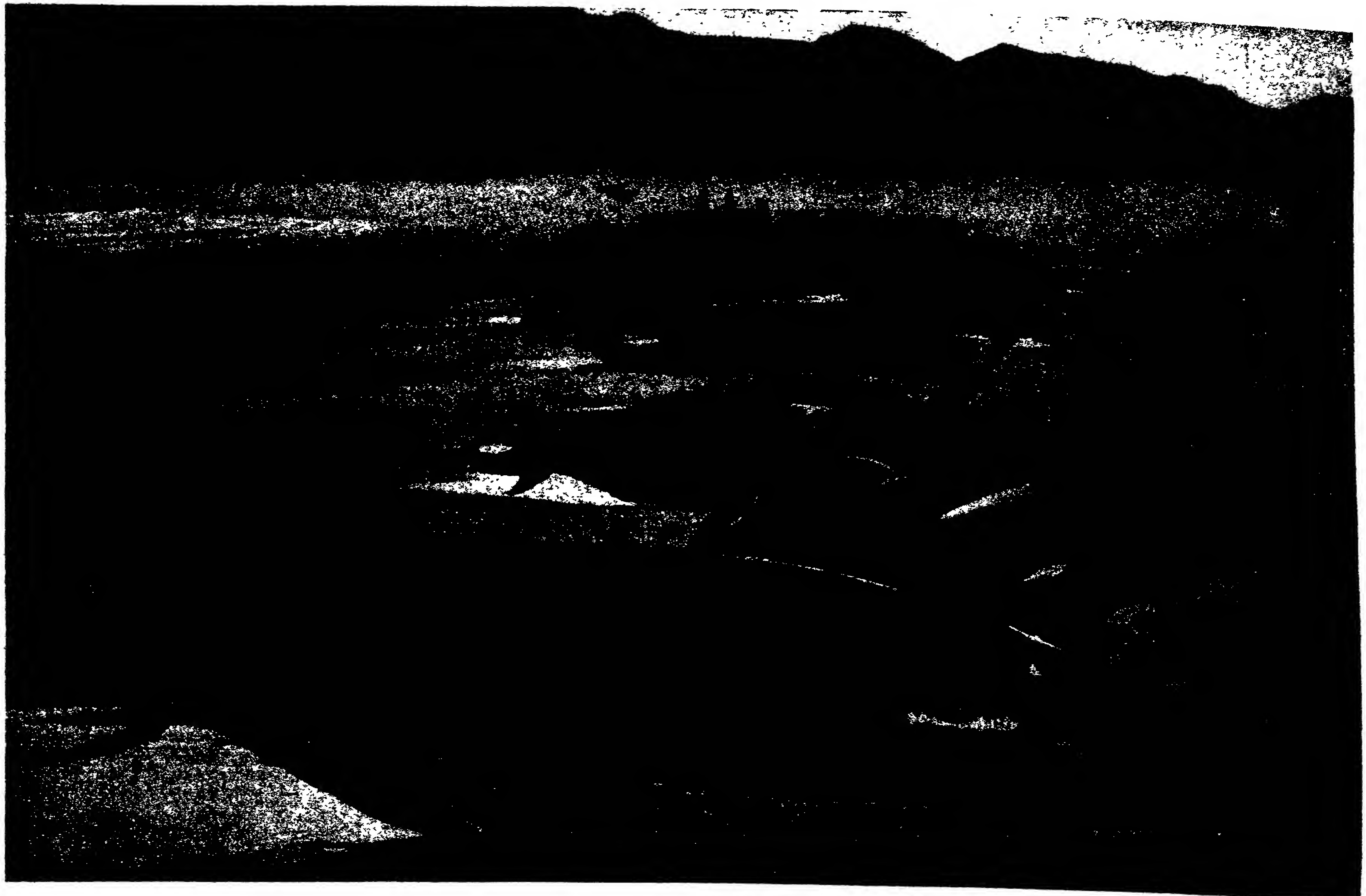
It is only gradually that the young are persuaded into the water, and at first they are not able to swim with the rapidity and ease of the parents; they must become used to swimming as a child does to walking, and it is because of this that they are nurtured ashore. After three or four months on the beach, during which time the males have become very much reduced in condition, the sea journey is begun again; the pups are now able to accompany their parents, and when they return with them the following year they are still playful and ready to gambol with their younger relatives when these arrive.



W. S. Berridge

COMMON PORPOISE THAT OFTEN ASCENDS THE THAMES

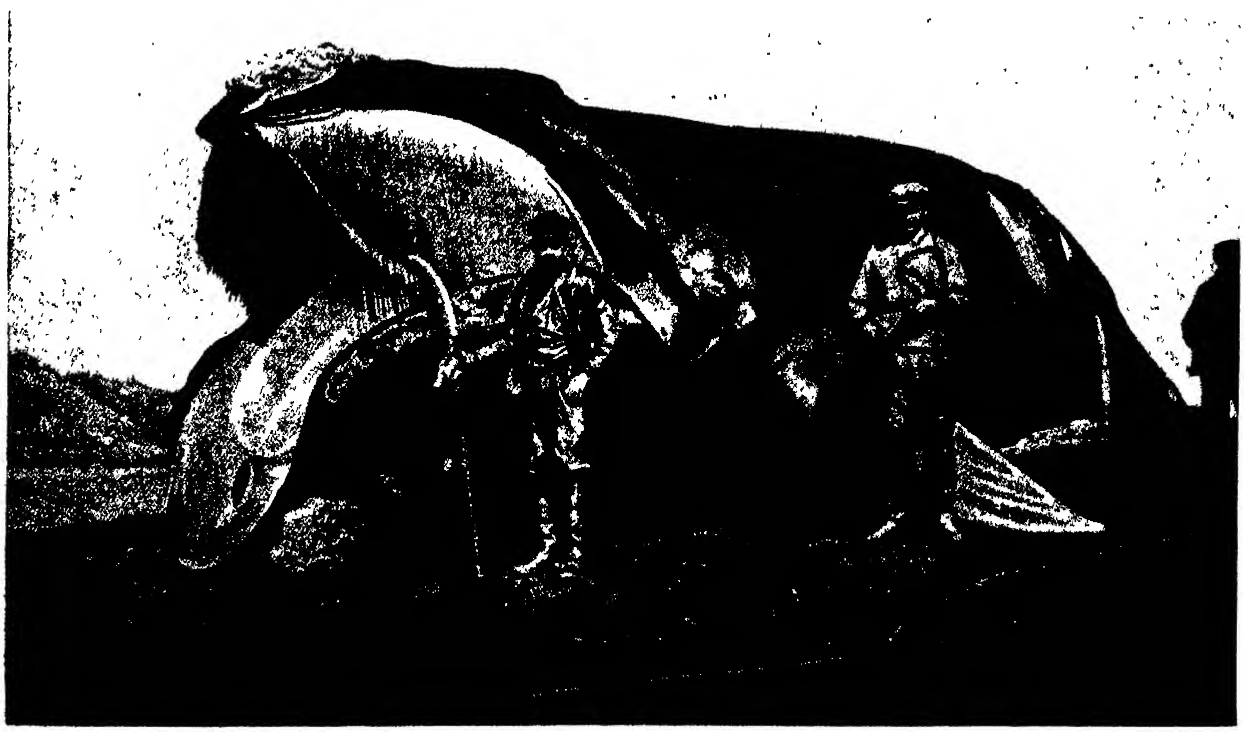
The porpoise is one of the smaller members of its family and is usually about six feet long. The name is perhaps derived from the French "porc" pig, and "poisson" fish, and it is quite a regular visitor to the coasts of the British Isles. Specimens have been known to ascend the Thames as far as Mortlake on the Boat Race course. Notice that the tail is placed horizontally and not, as in fish, vertically, a distinguishing feature of all the mammals of the sea which belong to the great family of the Cetacea.



SCHOOL OF WHALES STRANDED AND HELPLESS IN A SHALLOW BAY NEAR CAPE TOWN

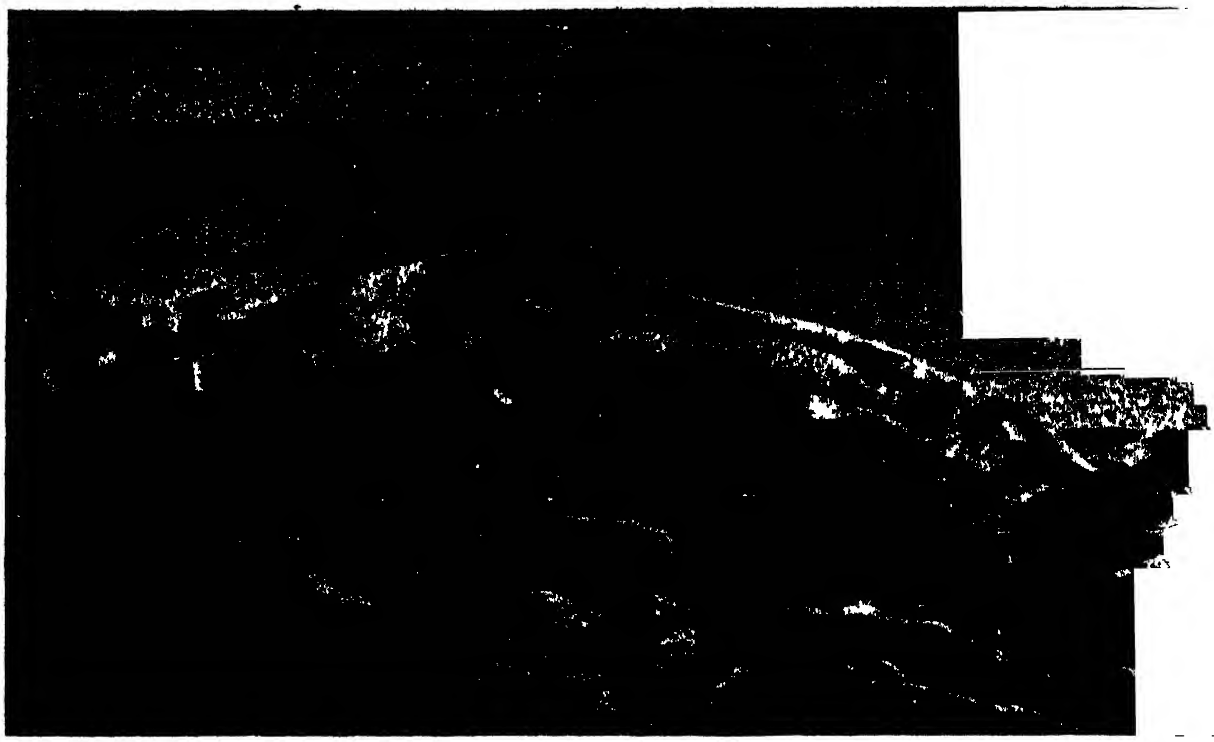
Many whales are gregarious and follow a leader just as sheep do, so that if one gets stranded by venturing too close to a shelving shore, the chances are that the whole "school" will share its fate. Our photograph shows a large school of more than one hundred whales which became stranded in a shallow bay not far from Cape Town. They lay about helplessly for some days, impotently lashing their huge tails, and some of the largest took nearly a week in dying. Meanwhile the local coloured population gathered at this wonderful chance of obtaining [illegible] and cut steaks-out of the unhappy creatur[illegible] which were [illegible]

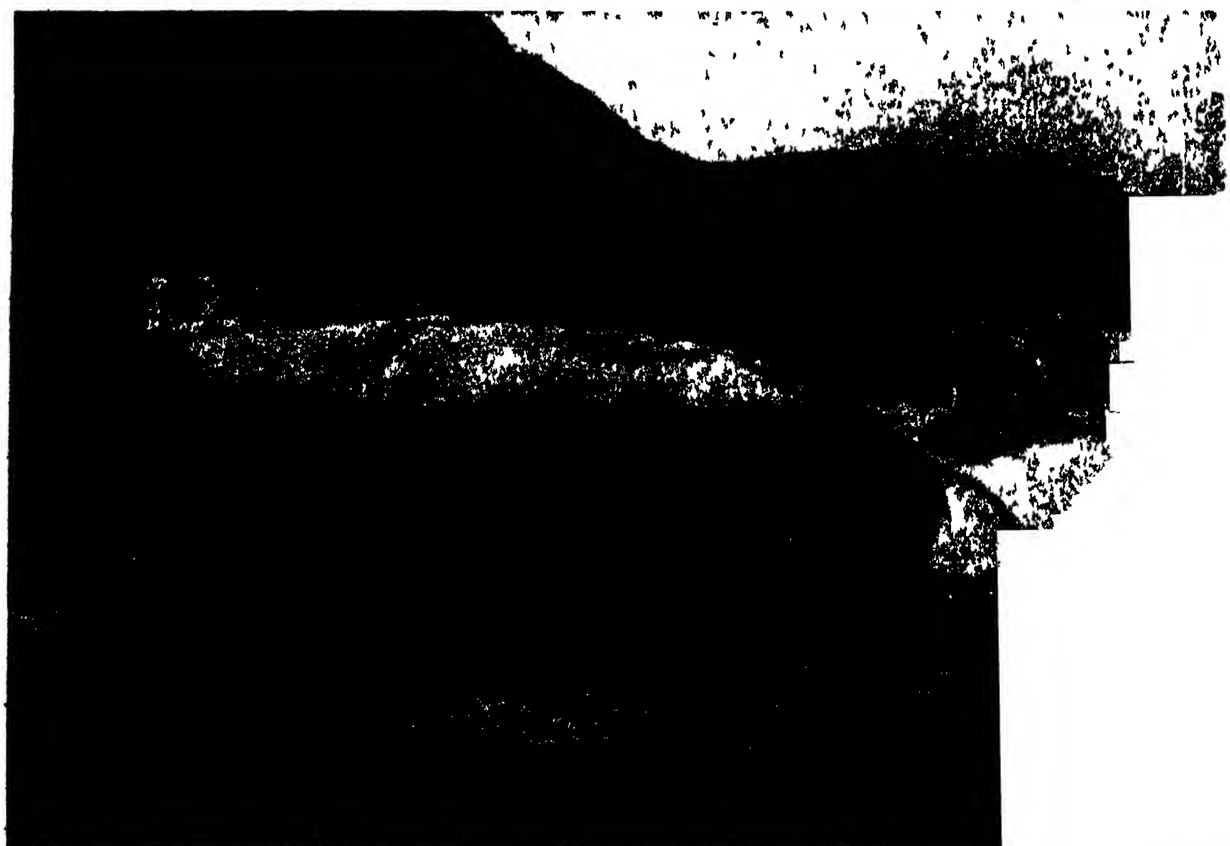
W. S. Berridge



BALEEN WHALE AND A SCHOOL OF PILOT WHALES STRANDED IN MOUNT'S BAY

Baleen or whalebone whales, a specimen of which is shown in the lower photograph, are toothless but have evolved instead a kind of sieve inside their enormous mouths. With open jaws they rush through the water engulfing myriads of animalculae. At intervals they close their jaws and force the water through the "sieve" of whalebone which allows the water to pass out of the lips, but retains the animalculae which are swallowed forthwith The upper photograph shows a school of pilot whales which has run ashore in Mount's Bay, Cornwall.

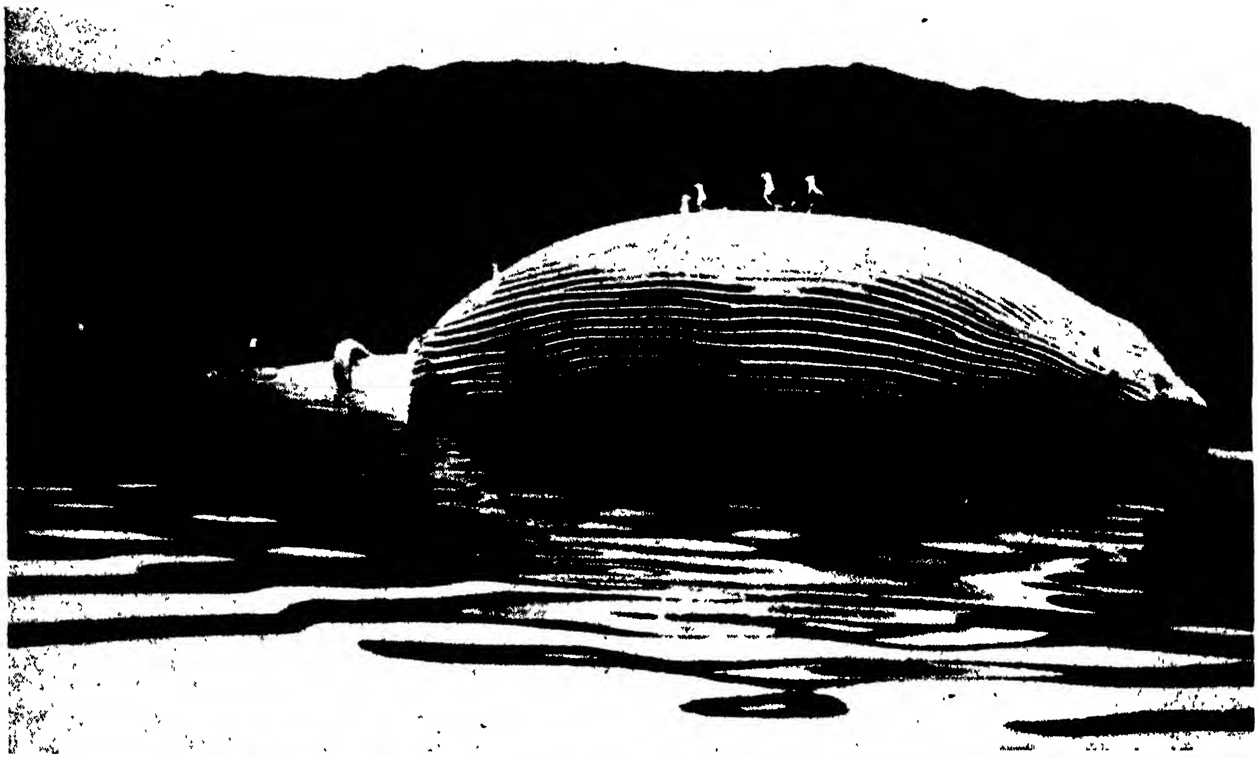


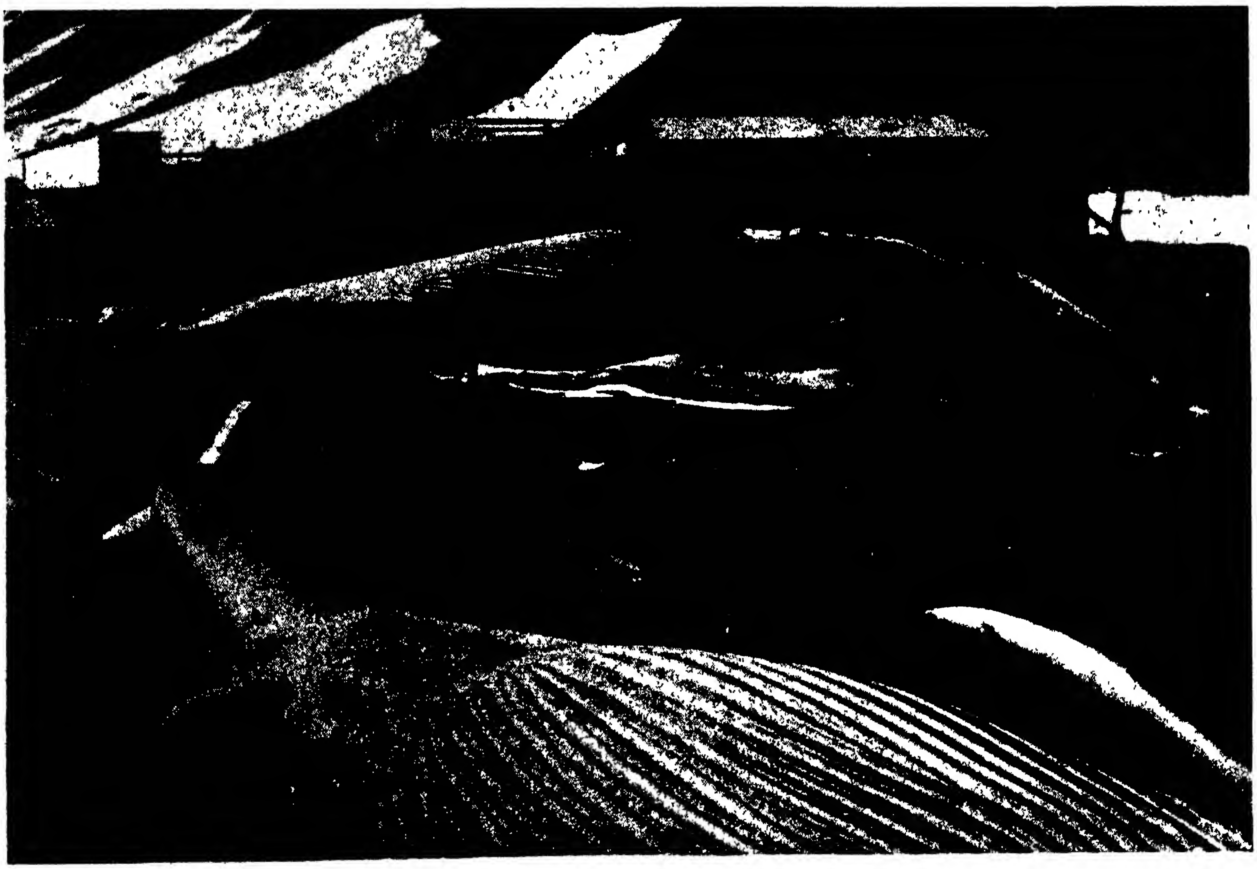


W. S. Berri

DEAD RORQUAL ON THE ROCKS OF THE YORKSHIRE COAST

These photographs of a stranded whale were taken on the rocky foreshore at Cloughton, just north of Scarborough. Four species of rorq are commonly found in the British waters, the one most frequently seen being the finner, which is from fifty to seventy feet long. T rorquals have a special modification of the throat and mouth, which are formed in a series of longitudinal pleats which allow of a considera amount of stretching when the animals are feeding. The structure of a whale's skeleton makes it helpless when stranded.



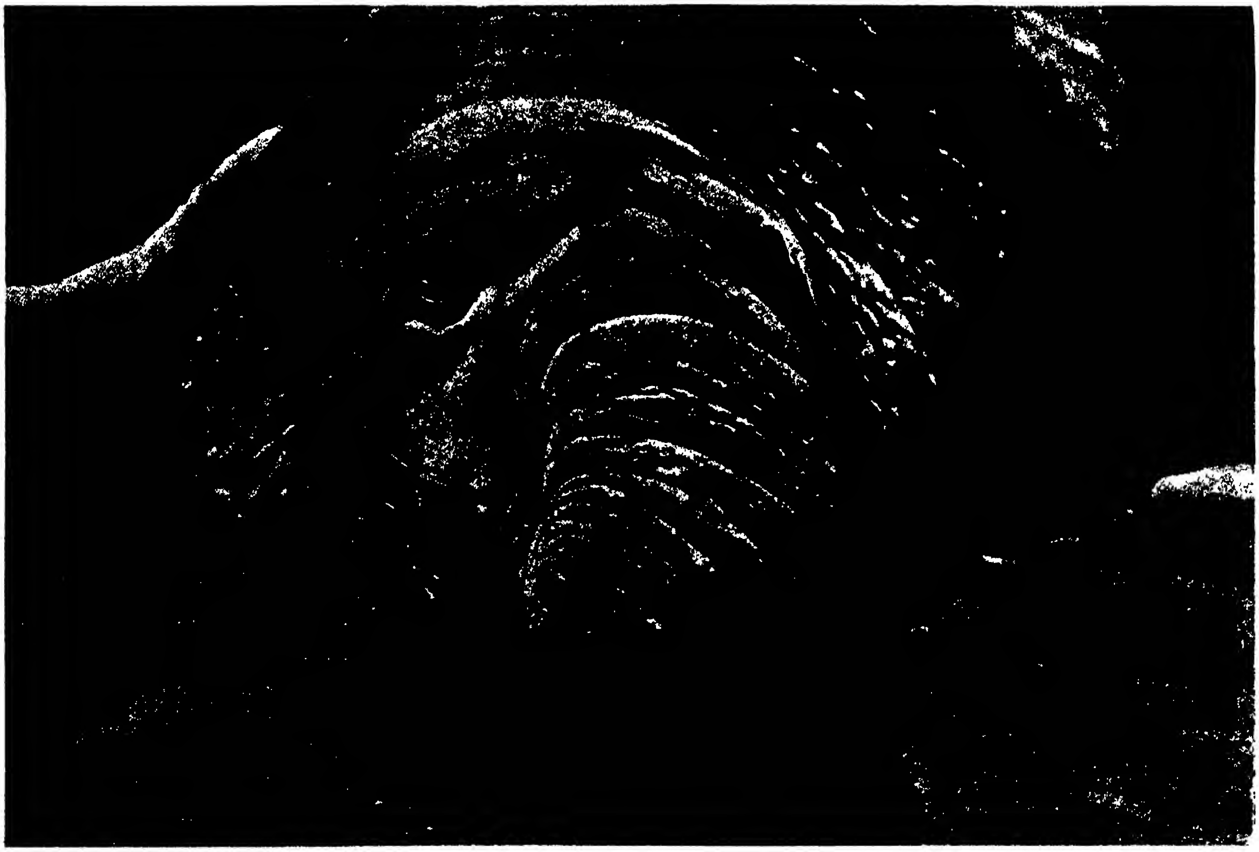


MONSTER WHALES AT SOUTH GEORGIA AND SPITZBERGEN

The blue whale is the largest animal in the world and a specimen thirty yards long is on record. In the old days monsters like this were not encouraging to attack when whaling was carried on from the ship's boats and the harpoons were thrown by hand. Since steamships and harpoon guns were invented, however, even the blue whale can be "landed." Below we see two of these enormous creatures on the island of South Georgia. Above is a whale's carcass inflated to keep it afloat.

EXCITEMENTS OF CAPTURING AND DELIVERING SEA-ELEPHANTS FOR A ZOO

When the San Diego Zoological Society, of California, U.S.A., wanted some sea-elephants or elephant seals for their gardens, an expedition set out for Guadalupe Island, which is some 140 miles off the Californian coast. Formerly the sea-elephants existed there in thousands but were very nearly exterminated till the American influence protected the animals. A bull and two cows were "cut out" of the herd by being fenced off in the manner shown. The fences were then put together as cages, and the animals towed off to a ship.



RESTING AND RAGING EXPRESSIONS OF A TWO-TON BULL SEA-ELEPHANT

When full grown the bull sea-elephant has a well-developed " trunk " (bottom). In repose the expression is calm and the eyes almost tender, but when anything occurs to upset the feelings of this fourteen feet of blubber and muscle the animal leaves one in no doubt as to its state of mind (top). These photographs are of the big bull sea-elephant captured with two cows for the San Diego Zoo, as described in page 740. After a little forcible feeding the animals settled down to about 120 pounds of fish a day between them.

the cachalot, are monsters in themselves, and the writer has seen one taken from the stomach of a whale, that, inclusive of the long tentacles, measured twenty-seven feet.

The sperms roam about in tropical and sub-tropical seas but certain of them also wander towards the poles, and in summer may be seen, for instance, off the west coast of Ireland. These when caught are found to be males and it is supposed that they are young or very old members of a herd that have been driven away by the stronger "bulls."

Contrasted with the dolphins and the cachalot are the whalebone whales, which do not possess teeth but have instead, suspended from the upper jaws, a horny substance that has generally been termed "whalebone" or baleen. This

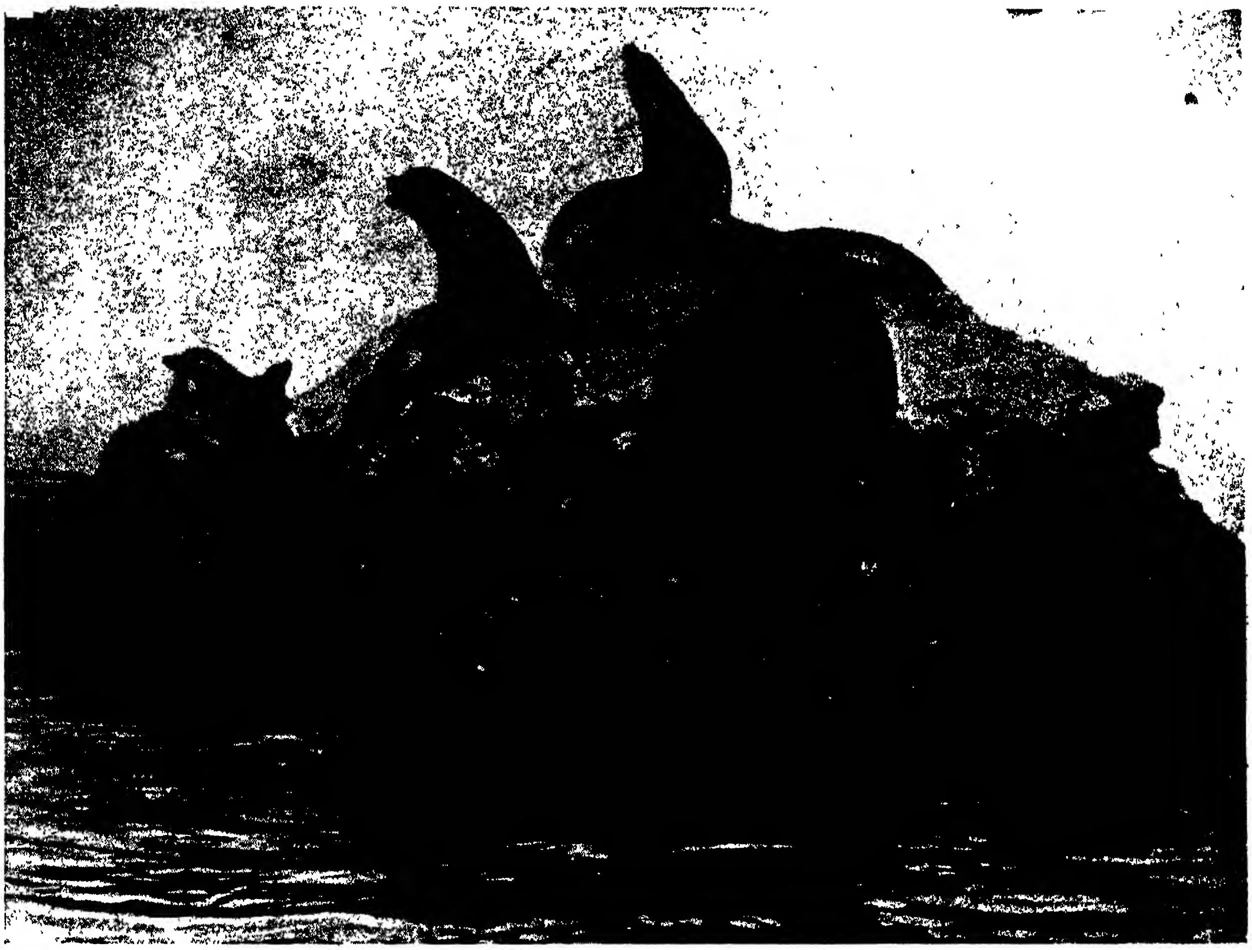
also belongs the common dolphin itself, with its long beak-like jaws and elegant slender body, and the smaller porpoises of our coasts. Both dolphins and porpoises are not uncommon sights, for they are fond of playing about vessels, but apart from this not much is known about their habits.

There are larger types of whale also that possess teeth, but these only occur functionally in the lower jaw. The best known and most powerful whale thus armed is the sperm whale, or cachalot. It grows to fifty or sixty feet in length and is readily distinguished from all other whales by its huge barrel-shaped head. It is a powerful diver and may "sound" for upwards of an hour, during which time it is seeking its prey in the form of squids, animals of the octopus family that apparently exist in tremendous numbers of the ocean. Some of these squids, although insignificant in size when compared with

W. S. Berridge

SEA-LION BEHAVIOUR IN CAPTIVITY

The hind limbs of the sea-lion are more adaptable for life ashore than in the other seals. An example of this occurs in the lower photograph in which we have a sea-lion scratching the back of its neck with one of its hind flippers which is as convenient for that purpose as the hind leg of any puppy. When in the water (top) the limbs are used only for steering.



SEA-LIONS ASHORE ON THE ROCKS TO BASK IN THE SUN

Where they are not accustomed to be disturbed sea-lions can be approached if caution be used so that the animals do not become alarmed. In the lower illustration one of these creatures is lying happily on its side so that the sun can shine upon its stomach. Despite the nearness of the photographer the animal has not bothered to move from its comfortable position. Above are some sea-lions basking on the rocks at Santa Catalina Island, off California These are roaring at intruders who have invaded their peace.

material exists in plates that are divided on the inner side into a myriad of bristles. These bristles bridge a space left between the upper and lower jaws when the mouth is closed. In spite of a lack of teeth the whalebone whales are carnivorous in nature and the manner of feeding happens thus : the mouth of the whale, large even for so great an animal, is opened and water taken into it ; the cavern is then closed again and the water forced out of it with the assistance of a huge mobile tongue. The bristles of baleen stretching across the jaws thus act as a sieve that allows the sea water to pass through freely but enmeshes the contained animal life. The shrimp-like creatures caught thus are minute in size, and so the whale depends upon the myriads of them that occur in the upper waters of the sea.

To this type belongs the Greenland Whale, which used to be hunted from small rowing boats amongst the icefloes bordering the Arctic Circle, also the Blue Whale, which has been recorded up to a hundred feet in length and may be considered the largest of all living creatures. Like the smaller finner whales which are fairly common off the British coast, the Blue Whale is comparatively active in its movements and so it could not be tackled successfully by the older methods of whaling.

With the introduction of small steam whalers armed with a harpoon gun and working from a shore station, however, such types may now form the bulk of a whale fishery and so the industry is carried on both North and South of the Equator in places as far apart as South Africa, Japan and the Falkland Islands. The oil, or blubber is still the most valuable commodity obtained from these animals, and it is used in quantity for making margarine.

It is the sea, therefore, and not the land that supports the largest of creatures, for an elephant is but a pigmy compared to the greater types of whale, and two main factors that determine this position may be considered. First of all there is the problem of a food supply for such tremendous bulk, and here it has been seen that the whales are most fortunate, for they are able to garner huge quantities of concentrated animal food the like of which does not exist even in the lands of the luxuriant tropics. Thus the sperm whale seeks below the surface of the water for the shoals of succulent squids, while the baleen-carrying whales strain from the sea the countless numbers of animalculae that exist in it. Nor is such " pasturage " easily exhausted, for the whales have practically the whole of the limitless ocean for their journeyings. In this respect they have an advantage over certain gigantic extinct marine reptiles, for these were probably very sensitive to temperature changes and evidently preferred the conditions of the warmer seas.

Then there is the mechanical problem of supporting a huge heavy body. A land animal may be regarded as a bridge with the legs as supporting piers that take the whole weight of the animal and have at the same time to be mobile. In the case of the elephant the limbs are strengthened and buttressed by huge sinews and muscles, but there is a natural limit to this type of structure.

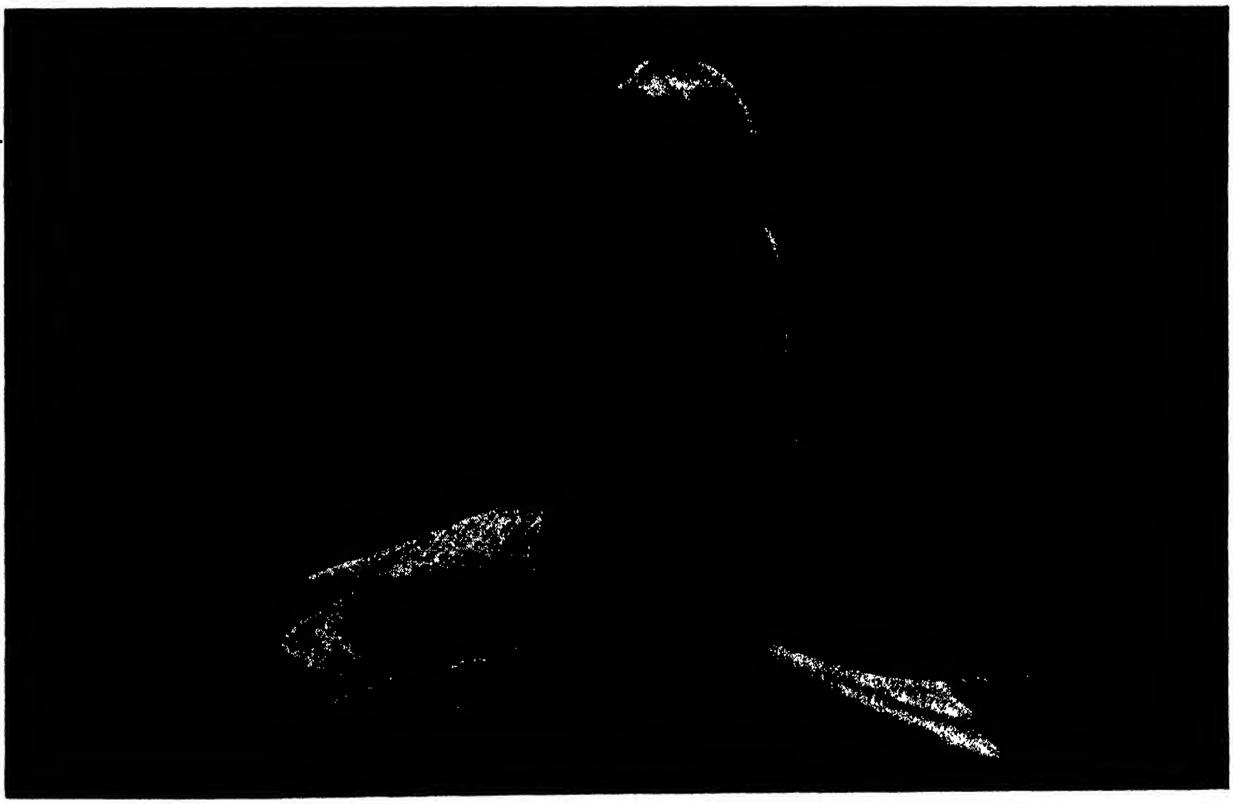
With the whales, however, the support of the body weight does not enter as a distinct problem ; the animal is cradled and buoyed up by the surrounding fluid so that the structure is concentrated upon affording the necessary rigidity for movement through water, a problem that is compatible with great size as may be noticed in the case of ship-building. This specialisation of the whale for its particular environment is shown by the manner in which it collapses when on the beach so that the organs are not able to function properly, and in consequence the animal dies.

Apart from the seals and whales there is another group of mammals, the Sirenia or sea-cows, that may be regarded as marine, although its members never venture into the open sea but hug the shoal waters and lagoons of the tropics. They are smaller and more squat than the whales but somewhat similar in appearance, so that in the past they have been confounded with them. The head, however, is rounded, and there is a well-marked neck ; the nostrils are at the end of the muzzle as in most land animals and not on the top of the head, and the skin is covered by a growth of short stiff hairs. Their mode of life and feeding is different also, for they browse upon the luscious marine and fresh-water weeds that abound in shallow water, seizing them in a mobile mouth and grinding them with strong molar teeth.

The two living types of the sea-cow are the manatee and dugong. The latter is found in the Indian Ocean and differs mainly from the manatee in having a forked tail instead of one rounded in shape. The manatee itself is common to the West Coast of Africa and to the east coasts of Central and South America, and is similar to the dugong in habits. It may be submerged for about twelve minutes and then rise for air, breathing quickly several times before descending again.

The nature of the sea-cows leaves them open to attack by man, and it is not surprising therefore that one species, Rhytina or Steller's sea-cow, discovered over a limited area within the Arctic Circle as late as 1741 and slaughtered for its oil, was rapidly exterminated. Thus the question presents itself as to whether the seals and whales also may not succumb to man once a hunt is organized against them either on the grounds that they are competing for fishery " rights," or because they yield commodities of commerical value.

The Greenland Whale has been hunted almost to the point of extermination, and although sperm whales are still harpooned they no longer supply a whole " fishery " but are only taken incidentally. In view of past experience it would seem that some restrictions may be necessary to prevent marine mammals from being over-exploited.



CAPE AND CALIFORNIAN SEA-LIONS, AGILE IN WATER AND ON LAND

Of the Pinnipedes (wing-footed animals) the sea-lions are the most active on land. They can double the hind limbs under the bodv and use them as legs. They can achieve a kind of shuffling rocking gallop and, not only that, but can climb over rocks and up steep places in the most surprising way. In the water these useful strong hind limbs are not employed for swimming but only for steering. Below is a Cape sea-lion with very large and powerful fore-flippers and above is a Californian sea-lion

Arthur Brook

PART OF A HERONRY BUILT IN THE TOPS OF HIGH TREES

February is the usual month for the herons to start nest building and this they do in colonies. The site most often chosen is a clump of high trees in some copse or spinney but cliffs and steep places in the sides of hills may be used. The nest, which is built of pieces of stick and is lined with grass, twigs and roots, is broad and flat. Three or four eggs are laid and hatched in about a month and sometimes another clutch is laid two weeks later and hatched among the growing chicks of the first brood.

Chapter LXIX

The Nesting Habits of British Birds

By Edward Step

Author of "By Vocal Woods and Waters"

ALTHOUGH the first birds inherited from their reptilian ancestors the method of propagation by egg-laying, and probably left their eggs to be incubated by the sun, or by covering them with fermenting vegetation, most of them found that a more certain way was to sit upon them, so that the warmth of their bodies might be transmitted to the living germ and the period of development in that way might be shortened, the hatching hastened and the brood protected. The Megapodes of warmer climes still shift, like tortoises, their parental responsibility on to the sun; but whilst a number of British birds retain the primitive habit of dispensing with nest-building, only one neglects incubation, though she—the cuckoo—is careful to foist the task parasitically upon some other bird.

Most of the British birds which have retained the primitive habit of laying their eggs upon the ground, with little or no attempt to construct a nest, are those of the sea-coast, and these chiefly the group that includes the oyster-catcher and the plovers. The first-named handsome bird merely scrapes in the upper part of the shore a saucer-like hollow. In the depression three (occasionally four) buff or olive eggs, all blotched and streaked with black, are laid, with their smaller ends in the middle to economise space. The stone curlew, or thick-knee, lays its similar, but lighter-coloured eggs under much the same conditions, on the upper shore or on a waste running down to it. That the eggs harmonise with their surroundings sufficiently to afford protection is shown by the fact that only two are laid. The sandy-coloured young are quite as difficult to see as the eggs were.

Other plovers, such as the lapwing and the golden plover, make some advance to what we should consider comfort by selecting a slight hollow among inland vegetation and introducing a little dried grass or some dead leaves as bedding. But what looks like the most casual and risky of all egg-laying is that of the guillemot, which has only one large egg to venture, yet places this on the crowded bare stone shelf of a high sea-cliff. The conical shape of this egg, which allows it to roll only in a small circle or to revolve upon its own axis, has been used often as an example of adaptation to situation; and many have believed that it is really perfectly safe upon its narrow shelf.

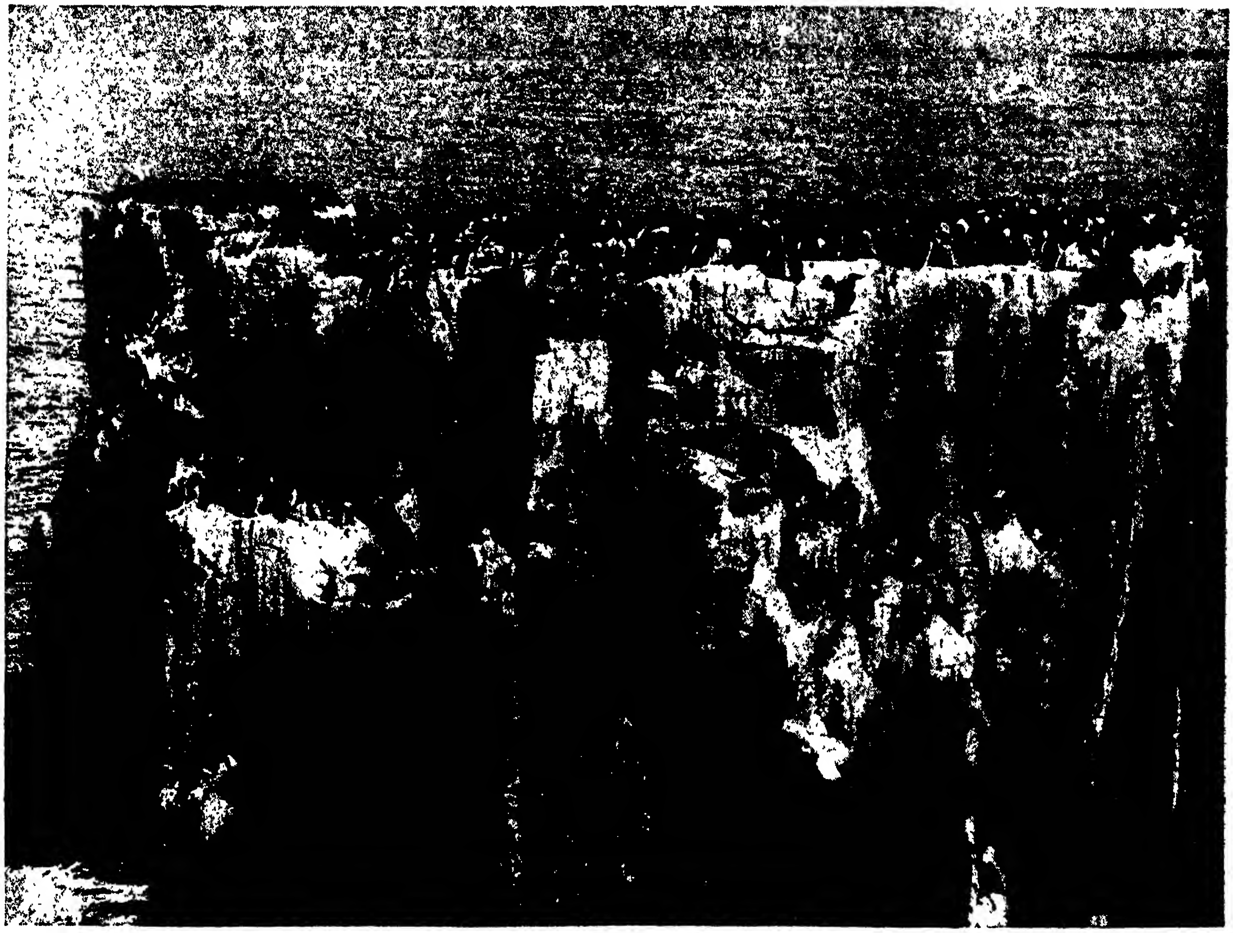
WE have seen thousands of brooding guillemots on the ledges of a lofty headland alarmed into sudden flight by the horrid screeching of the siren on a pleasure steamer. Most of the eggs spun round without leaving their shelf, but a number rolled into the deep water below. No egg is subject to greater variation than this; and it has been said to be all but impossible to get two guillemots' eggs that are exactly alike. This, however, refers chiefly to colour and markings; but it seems pretty clear that the eggs that rolled into destruction varied somewhat in shape from the normal.

UNPROSECUTED TRESPASSERS

Turtle doves, like all their tribe, build only the simplest of nests and sometimes make them on top of an already occupied nest belonging to another species. Here it is a pair of song thrushes whose home has been used as a foundation.

The razorbill, though its solitary egg is smaller than that of the guillemot, less produced at the thinner end and therefore more disposed to roll, breeds on the cliff face, but selects the holes and the broader terraces where there is less need for this structural peculiarity of the egg. Although the bed is stony no effort is made to soften it by a scrap of dry grass or seaweed, though this might be furnished with the greatest ease.

Among our inland birds the nightjar affords an example of egg-laying upon the bare ground, at the most among the natural débris of heather and bracken or the fallen leaves on the edge of a wood. But though laid with seeming carelessness, often quite in the open, the two eggs appear to be perfectly



Peter Webster

GUILLEMOTS ON A NESTING ROCK AMONG THE FARNE ISLANDS

Some birds take much, others very little, trouble over nesting, but of all the casual ones, the guillemot seems to take the prize. This sea-bird not only neglects to make even the suggestion of a nest but deposits its single egg on a ledge in the cliff and holds it, point outwards, between its legs. The egg has the shape of an attenuated pear and will roll only in a small circle. Probably only badly shaped specimens ever fall off the ledge. Here we see one of the colonies in which the guillemots always gather.

secure, for the average wanderer would pass them by as small pebbles, which they resemble closely. So with the two chicks—their covering of sooty grey down renders them invisible among the soft shadows of twilight, when they are left alone.

The grotesque-looking puffin, another of the marine birds that lays but one egg, prefers the grassy summit of the cliff, where in company with a few or many of its kind it either excavates a tunnel of its own or appropriates the burrow made by an adventurous rabbit. Here, though a weatherproof dwelling is provided, there is no pretence of nest-making or the provision of even a slight bed for the white egg or the blackish downy chick.

This utilisation of holes for breeding purposes was, doubtless, one of the earliest devices of the primitive birds, as an improvement upon the open ground laying; and we see it continued to-day by the splendid kingfisher and the sand martin, though the latter has more refinement and furnishes the tunnel she has made with a bed of dry grass and feathers. The hollows of decayed trees, also, appear to have been seized upon by those early birds that preferred a woodland life. Many of them have kept up the practice to the present day; and we find the owls inhabiting hollows in more or less ruined tree-trunks, but making no attempt to furnish the apartment with bedding. This is not the only resort of the owls, for they are not above taking advantage of any suitable hole, or even adapting to their purposes the nests of rooks or crows or convenient ledges in barns or church towers and steeples.

Another of these nesters in decayed trees is the wryneck, which has no sense of providing comfortable bedding for its young beyond the scratchable spongy wood already there. The nuthatch, with similar habits, has some building skill, for where the entrance is larger than is necessary it obtains mud and fills up the surplus space, thus probably keeping out some objectionable visitors.

The wryneck's relations, the woodpeckers, which have the same habit of nesting in decaying trees, prefer to make their own entrances and excavations

ascertaining by the sounds caused by their tapping bills where the wood is soft enough for their purpose. There a clean, workmanlike hole is cut through the bark and into the interior wood. The only bedding material is such scraps of rotting wood that the carpenter may have failed to clear out.

An advance upon these rude nesting places was made when some birds realized that soft bedding was desirable for such fragile treasures as eggs and for the tender, naked bodies of newly-hatched young. The common tern, nesting in companies on the sea-shore, lines its depression with a little dry grass or else some fine seaweed.

More definite approach to nest-building is shown by the gulls, which make rude cushions of gathered vegetation, and, the birds being sociable, large numbers of the nests may be crowded together, often touching. One of the most striking and easily seen of these associations is that of the black-headed gull, which breeds inland in marshes and around pools. In their favourite resorts many thousands of the nests may be visible at one view, those on the drier ground mere hollows in tussocks of coarse grass; but in the wetter parts of the area there are beds of flag-leaves, reeds and sedge, lined with moss and other fine material. There the three (sometimes four) heavily spotted eggs—that appear on the table often as plover's eggs—are laid, and later their place is taken by the black-spotted downy chicks that are able to run and swim at once, though they look to their parents for food.

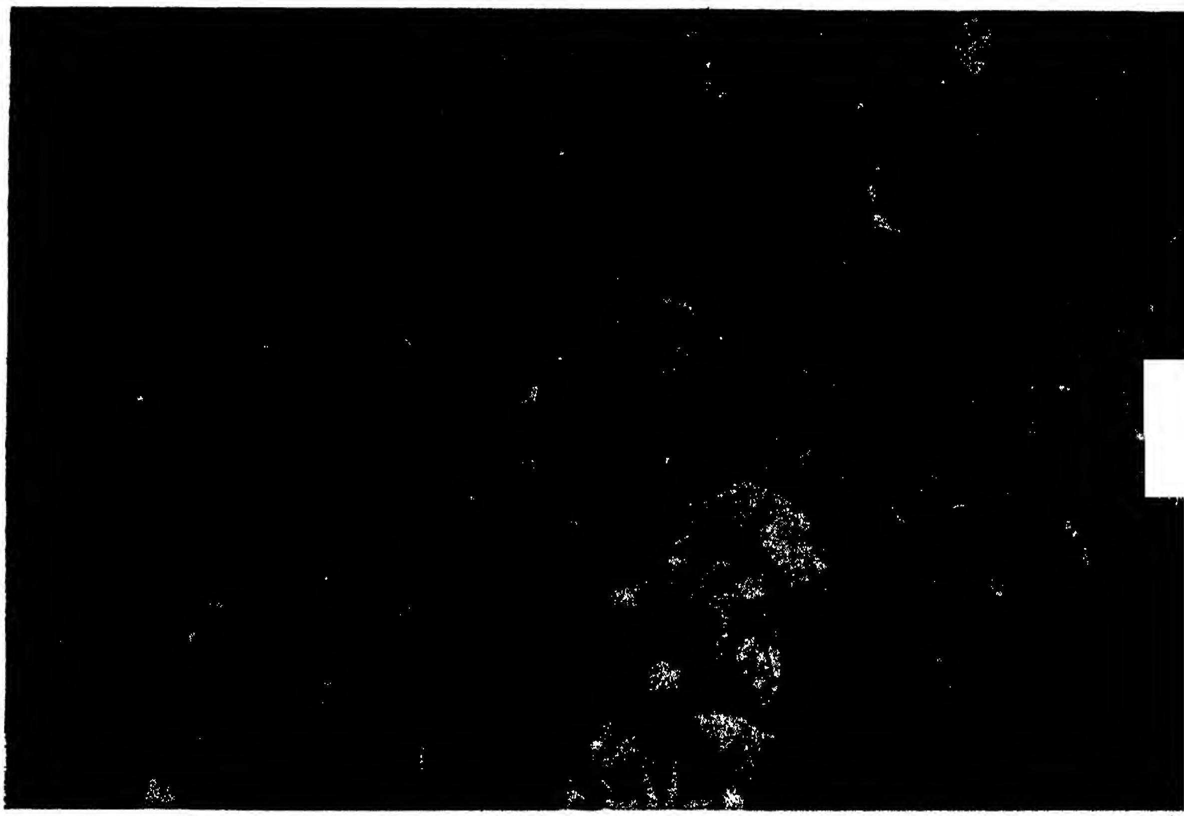
The herring gull and the common gull, which prefer the ledges of cliffs and the tops of high rocks surrounded by sea for their nest communities, make a rough platform of twigs and dry seaweed, lined with grass and seaside herbs, but its flatness and lack of weaving show that it is primitive. In essentials the nests of rook and crow, though built on the higher branches of trees, are of the same elementary type; still, they exhibit a considerable advance, for the foundation of twigs in that of the rook is made firm by the aid of mud, and the cup is lined with grass and soft roots, whilst the crow achieves comfort by the use of hair and wool as well as grass.

JACKDAW and magpie show the same liking for sticks as a strong foundation, with a more comfortable lining of softer stuffs. Though both may be found in trees, the jackdaw has a fondness for ruins and steeples, where it often accumulates an unnecessarily huge pile of sticks before beginning the collection of feathers, moss and wool for bedding purposes. The magpie's root-lined nest is a more finished production, showing greater art in the contrivance of a dome and a doorway, the latter often framed with thorny branches. A vast amount of

A. H. Willford

MALE OYSTER CATCHER TAKING OVER DUTY FROM THE FEMALE

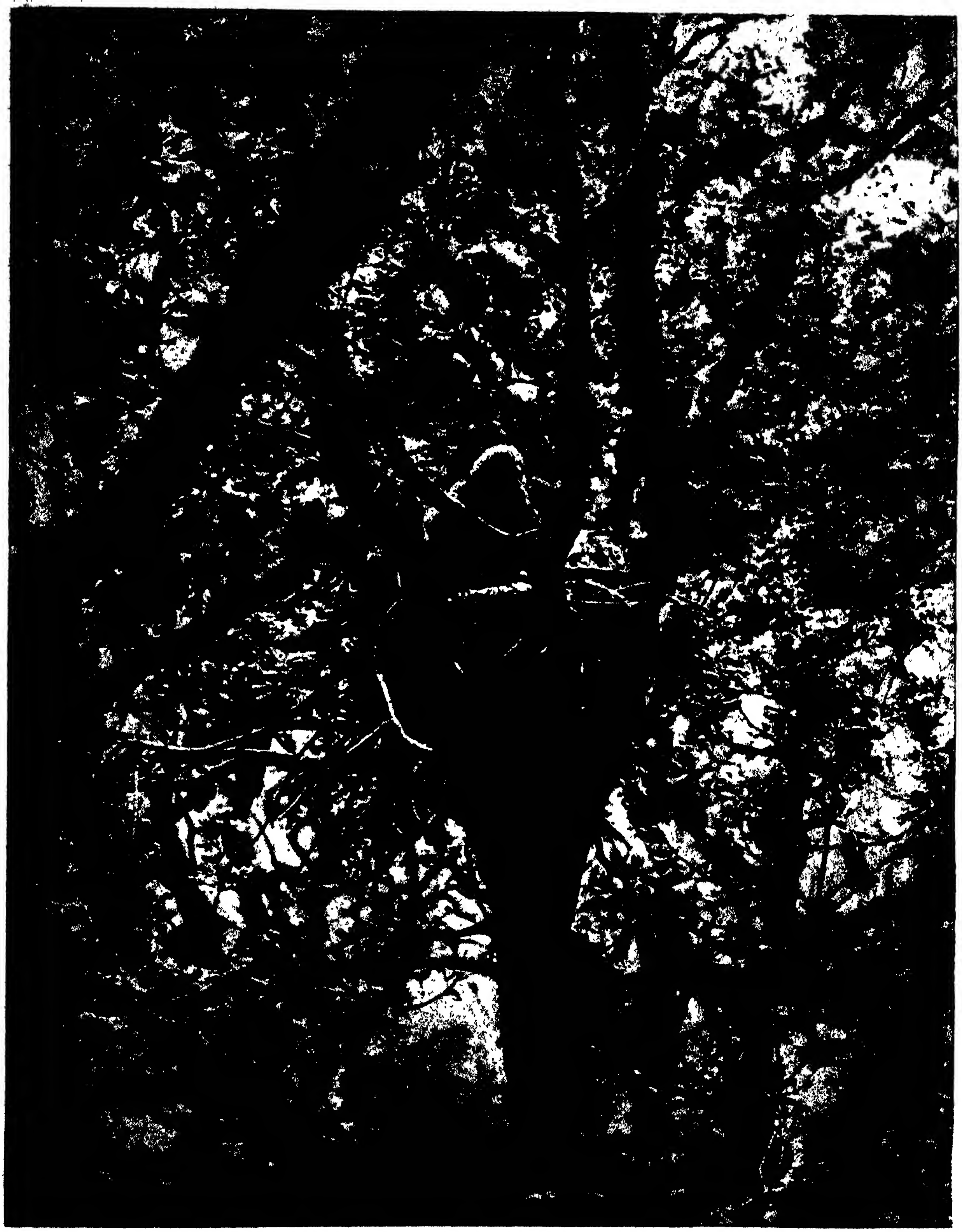
As a rule the oyster catchers lay their eggs in some little cavity among sand-hills or the shingle. There are usually three or four to the clutch, the shells being brownish yellow mingled with dark brown and grey markings. This remarkably skilful photograph was taken just at the rare moment when the father bird had returned to the nesting site in order to take over his spell of incubation while his mate went away to find her food. The female has just stepped off the eggs and the male is just about to settle.



A. H. Willfo

NESTS OF ROBIN IN A KETTLE AND OF MISTLE-THRUSH IN AN APPLE-TREE

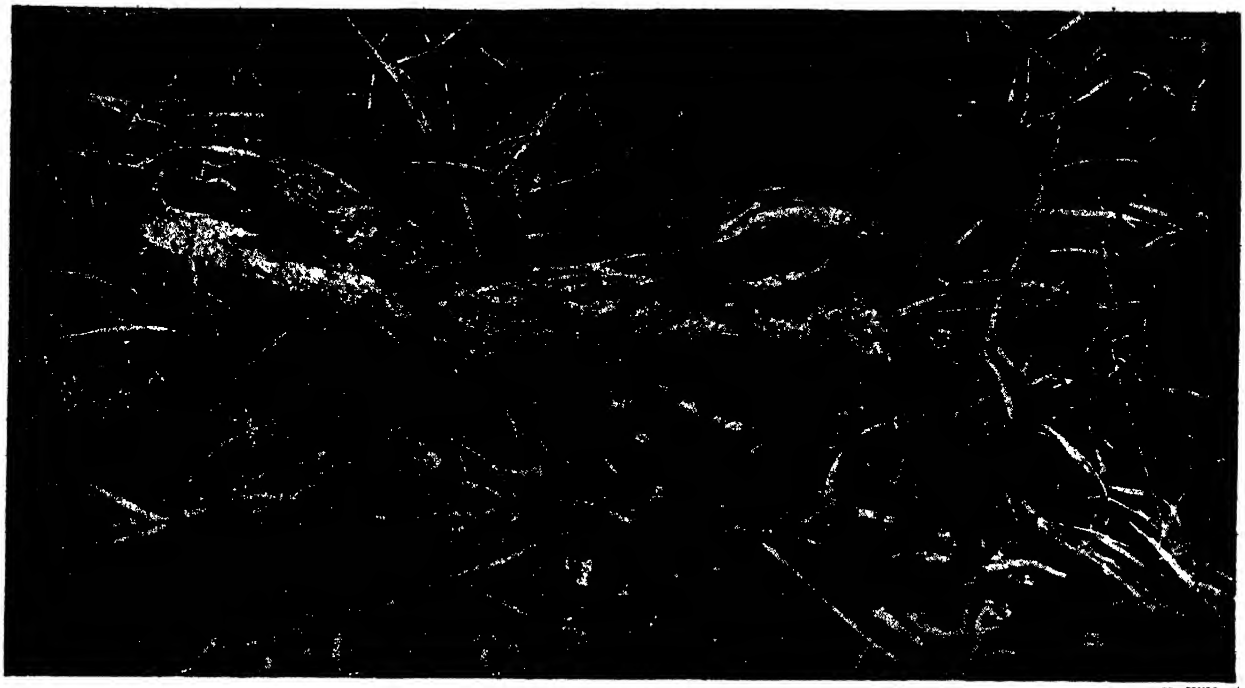
Robins repay the interest which men usually take in them and the sanctity which they usually enjoy at human hands on account of ol traditions by providing a certain amount of amusement. The little birds, besides their entertaining boldness, have a habit of nesting in th most extraordinary places, often choosing some man-made article for a nesting-place. Here is one (bottom) where a robin's nest has bee found in an old kettle pitched long ago into a quick-set hedge. Above is a mistle-thrush on its nest in an apple-tree.



Arthur Brook

PROBABLY THE RAREST BIRD IN GREAT BRITAIN: THE KITE AND ITS NEST

It is believed that only about six pairs of kites are now left to breed in Britain and all of these do so in Wales. In view of this it seems surprising that this bird has been recorded as having been common actually in the London streets as late as the sixteenth century, when it was regarded as a useful scavenger. Persecution has dogged the bird, and it was lucky for this specimen that it was a photographer, not an egg collector, who discovered its hiding-place. The nest is usually in a tree and is made of sticks, bones and even rags.



A. H. Willford

NIGHTJAR ON ITS EGGS, LAID AMONG SOME RUSHES

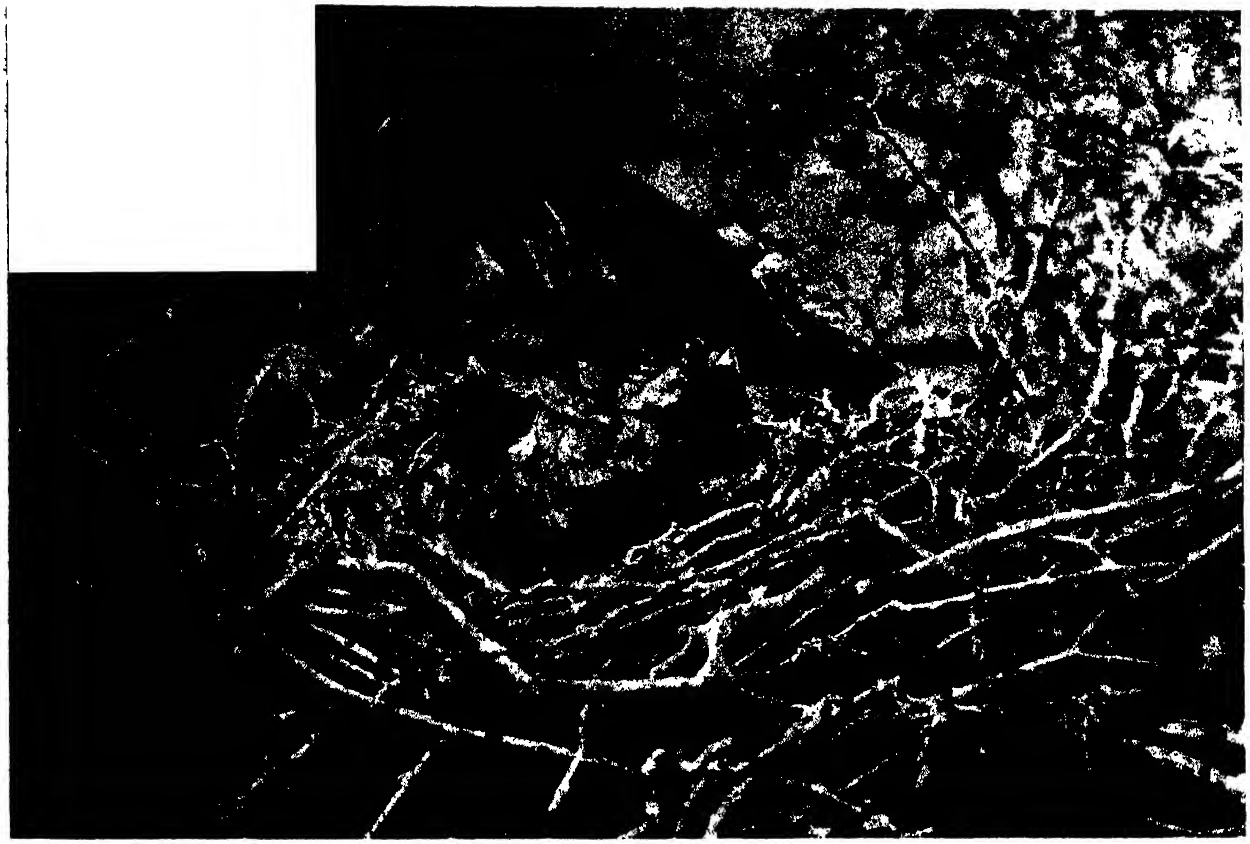
Two eggs are the common number laid by the nightjar and they are deposited on the ground without any attempt at making a nest. The bird relies on camouflage to make both it and its young ones safe. The nightjar which, despite its unfortunate name of "goat-sucker" lives exclusively on insects, always prefers uncultivated ground for its period of stay in Britain. The nesting site is usually found among bracken or gorse and the eggs are cream-coloured with brown, grey and purple-black markings.

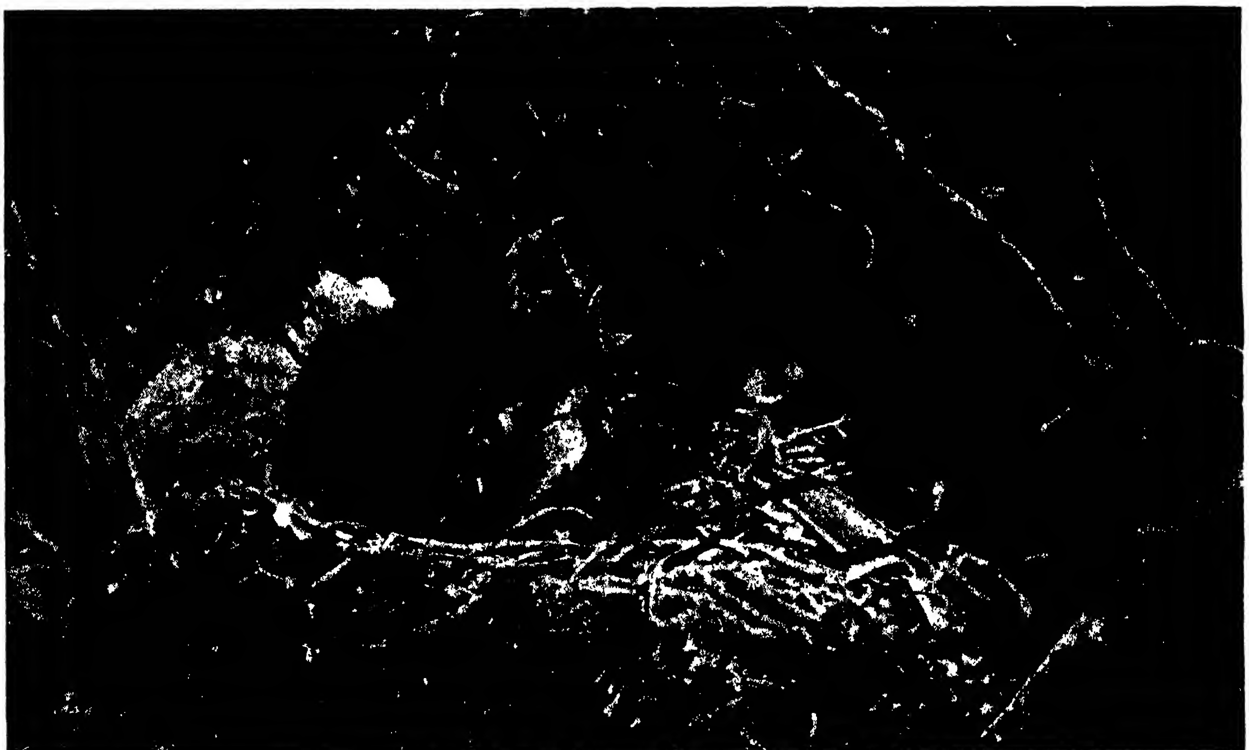
material goes to its construction; and next year the old nest may have additions to fit it for further use. Another crow, the beautiful and suspicious jay, is a far more neat and finished builder. She has no liking for the high, exposed branches of the tree, but builds lower where there is plenty of foliage for concealment. The nest is a deep, thick-walled cup of twigs, lined with soft roots and grass to hold the six or so eggs that are freckled with brown on a pale green ground.

The birds of prey are quite old-fashioned in their nesting habits; the kestrel being content with a hole of some sort, whether it be a hollow in a decaying tree, a rock crevice, the abandoned nest of magpie or crow, or some ruin to which it has access. There it lays its five roundish mottled eggs without any preparation in the way of bedding. The sparrow-hawk improves somewhat on this with a platform of sticks in the higher branches of a tree, and lines it with soft roots. The peregrine makes a similar nest —if any—on high sea-cliffs; but the merlin prefers the moorland, selecting a hollow on a heather-clad slope and lining it with dead heather twigs.

THE small group of native doves are users of sticks, but have not got beyond the skill of fashioning a simple platform, the blue rock dove, the ancestor of our domestic pigeon, being content with almost any rubbish with which to fashion a pad on a rock ledge in the sea-cave; and the stock dove sometimes constructs hers under a bush or in a tree-hollow. Each species lays only two white eggs, so they have not much to provide for. The ring dove or wood pigeon and the migrant turtle dove are satisfied with thin open-work, so loose sometimes that the eggs may be seen through it from beneath. That of the ring dove is balanced usually on the bough of a large tree or its sides supported on two neighbouring branches. The turtle dove builds lower down, in tall bushes or young trees. Once we met with it under peculiar conditions. A pair of song thrushes had made their nest between the forking branches of a young tree, and several eggs had been laid in it, when there came along a newly arrived pair of turtle doves eager to begin housekeeping, and these decided that the nest would make a good support for their flimsy floor.

As a rule, the fresh-water birds are not builders of very neat nests, the quantity of material being more obvious than fine workmanship. Most of them take advantage of the cover afforded by the abundant growths of reed, sedge and flag that mark off the firm land from the water; but some resort to holes in the bank, and others come very near to constructing floating rafts, though it will be found that these are based upon water plants growing up from the bottom. The little grebe and the coot make such nests, sometimes on the mud near the margin, but often far out from the shore, when they have the appearance of a free, floating mass of decaying weeds. Closer inspection will show that the upper surface is hollowed and lined with finer material to accommodate the eggs.

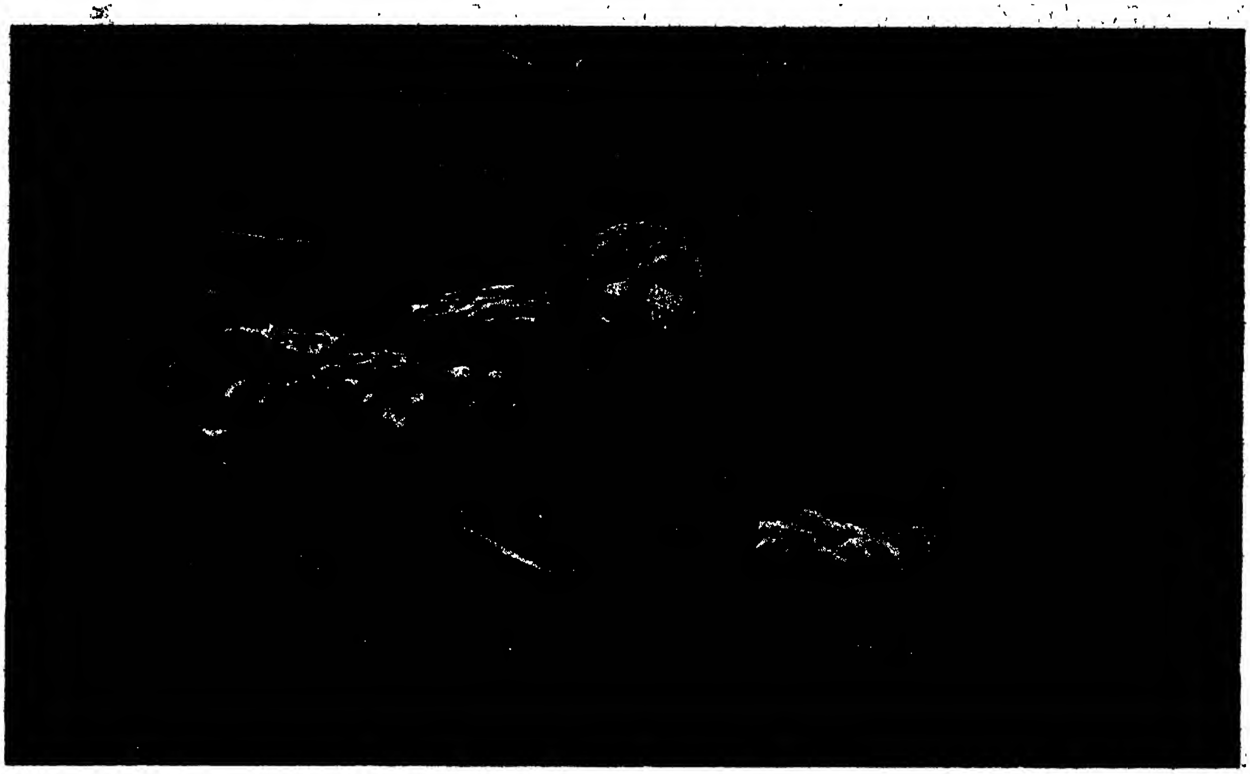


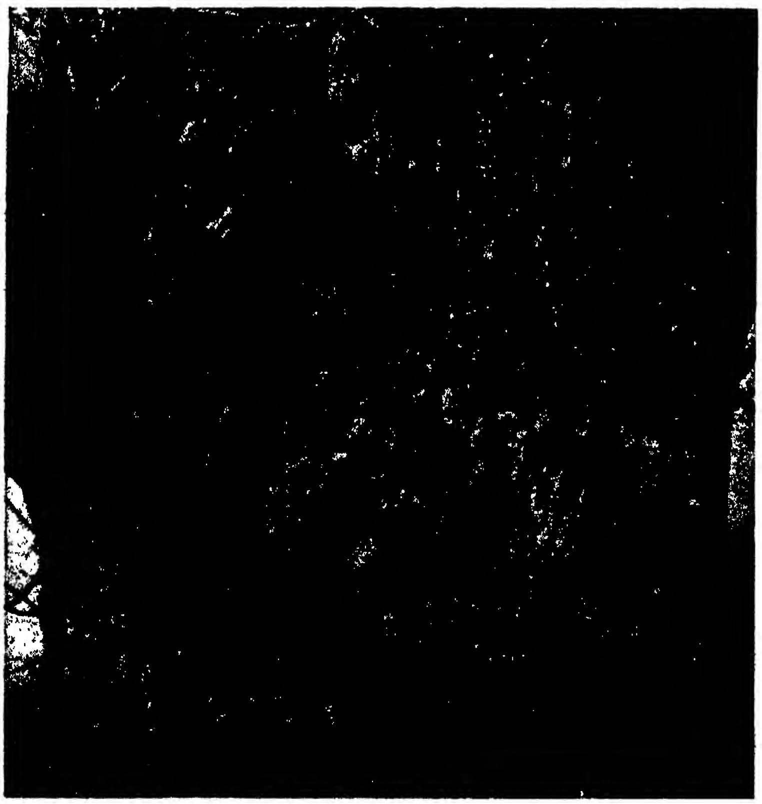


Arthur Brook

RAVEN AND CARRION-CROW FEEDING THEIR INSATIABLE YOUNG

Six infant ravens take a lot of feeding and this mass of yelling beaks (bottom) means hard work for the parent birds. Ravens are fond of nesting on sea-cliffs and especially on headlands and begin to nest in February in the south of England. The general mass of twigs is lined with wool and rabbit's fur, and from three to five eggs are usually laid. The carrion-crow (top) is fond of wooded country. The nest is made in April in a tree if possible. Like the raven, the carrion crow likes wool with which to line its nest.





Arthur Brook

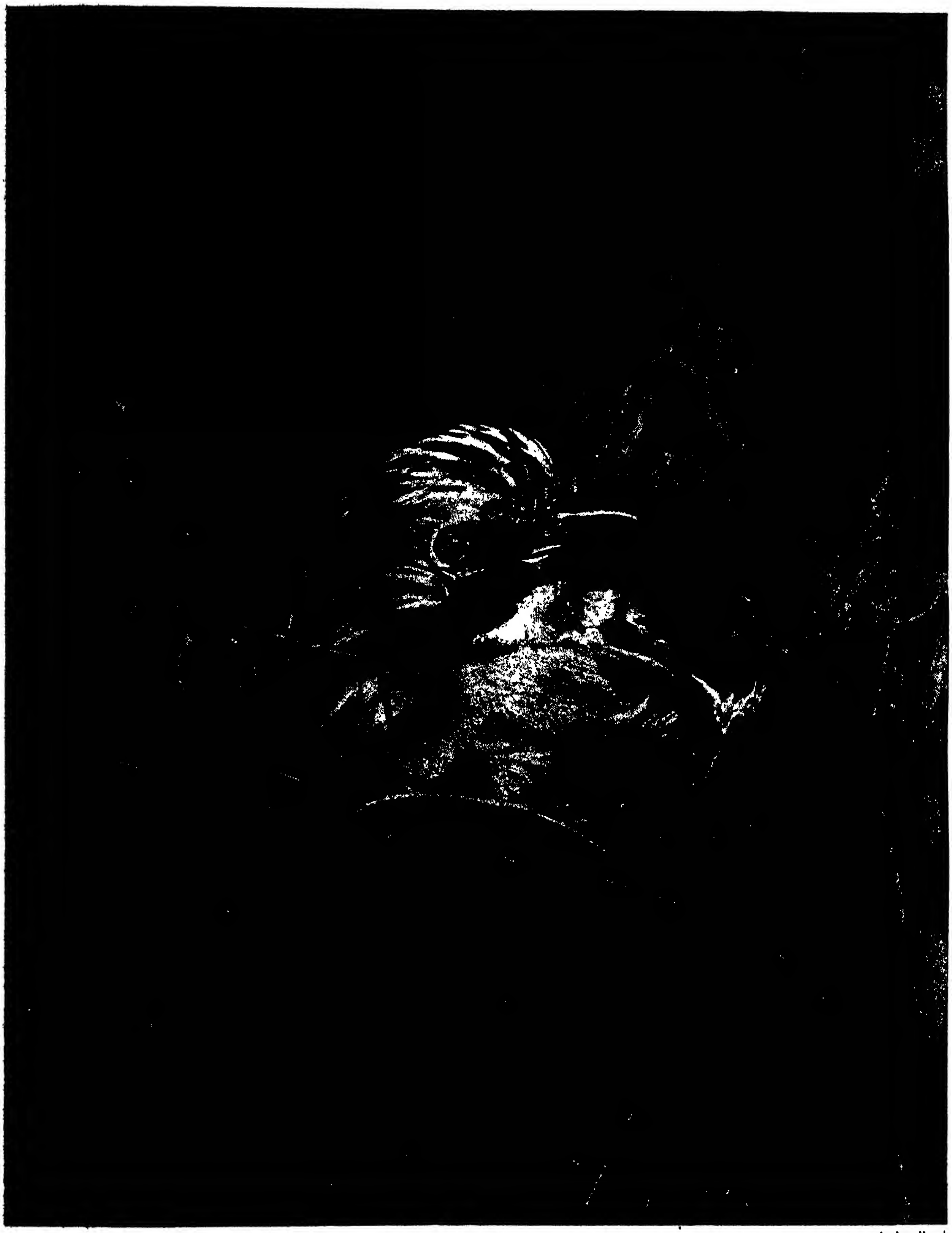
TAWNY AND SHORT-EARED OWLS

Hollows in the trunks of dead trees are the favourite places for the tawny owl to lay her eggs, though she does not trouble to construct any nest inside. The lower photograph shows a tawny owl about to enter the nesting hole in an old elm tree. Above is a short-eared owl which has deposited the eggs among some bracken.

The familiar moorhen prefers to nest in the screen of taller aquatic plants and is not averse from using the lower branches of a tree, the top of a pollard willow or some other unusual situation. Some years ago we photographed a nest on a Surrey pool that, to all appearance was floating in mid-water. The truth is, a gamekeeper finding one of his pheasant coops in a verminous condition had immersed it in the water for its purification, and on this the moorhen had built her basket-nest of alder twigs, rushes and grass, in which were six chocolate-sprinkled buff eggs.

The mallard, or wild duck, however, prefers to have her nursery at some distance from the water, and sometimes it is very remote, perhaps under a furze or blackberry bush. It is a bulky structure, looking as though put together hurriedly, and composed of reeds or rushes and dry grass; but it is made comfortable by a lining of down plucked from the breast.

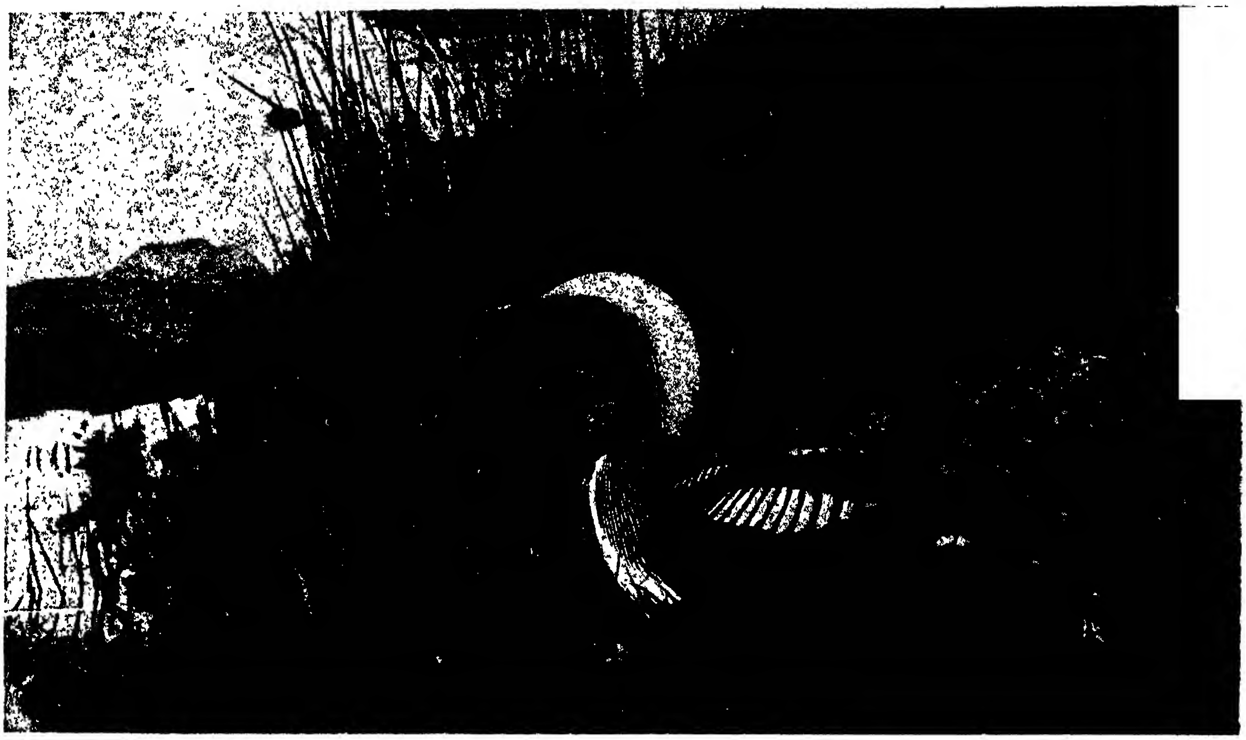
But it is among the smaller birds of our woodlands, commons and thick hedgerows that we must look for the most accomplished artificers in this kind; the makers of more or less neatly woven basket-work. These are by no means equal in proficiency, some of the nests looking as though their makers



Arthur Brook

REMARKABLE "CLOSE-UP" OF A JAY UPON ITS NEST

In a deep cup of twigs, thick-walled and lined with grass and roots the shy, beautiful jay, a relative of the crow, lays its half-dozen eggs. The jay keeps to the woods where the trees and bushes grow the thickest and makes its nest either in a bush, or else on the lower branches of a tree where the foliage is thickest. The remarkably handsome head is very noticeable here with its mottled feathers. The jay is busy at nest-making in April but only glimpses of its brown, black, white and pale blue plumage may be seen for this is a very shy bird.



Arthur Brook

WATER BIRDS' NESTS: LITTLE GREBE AND DIVER

What looks like a drift of floating weeds (bottom) is really the raft on which a little grebe has made its nest. The little grebe, or dabchick, lays its eggs between April and August and makes a large nest for so small a bird. But the nest is so well laid among the weeds that only a close inspection reveals it. Above is the nest of a black-throated diver beside a Scottish loch.

were not yet out of their apprenticeship, though following family tradition. They are not all tree or bush-builders, and ground nests call for less elaboration, as we see, for example, in that of the skylark. This bird is as careless as the shore birds and the plovers, nesting on open ground where the roughness of surface is the chief protection. There is better cover in the cornfield, which it selects sometimes, but often the nest is found in the pasture, in a depression made by hoof of horse or ox, and shielded only by rough grass or thistle. It is a loosely twined saucer of grass, lined with similar material of finer texture, and contains about five eggs that are closely speckled with some shade of brown with slight indications of a whitish ground.

The titlark, or meadow pipit, makes a nest of the same type, perhaps deeper, but places it less in the open, preferring taller, closer herbage ; and though dry grass is the chief material, the finer lining includes hair. Several of the buntings select the ground of fields, downs or hedgerows, but the cirl bunting prefers a bush or the low branches of a tree. The nests are substantial cups of grass, fine twigs or roots, with a lining of hair ; and the eggs are white with chocolate streaks that look as though scrawled with a pen, so that one of the group—the yellow bunting or yellowhammer—is known also as the scribbling lark. The reed bunting differs from the others by selecting marshy situations for its nest, which includes local material as well as grass, and part of the lining may be the soft plumes of the reed.

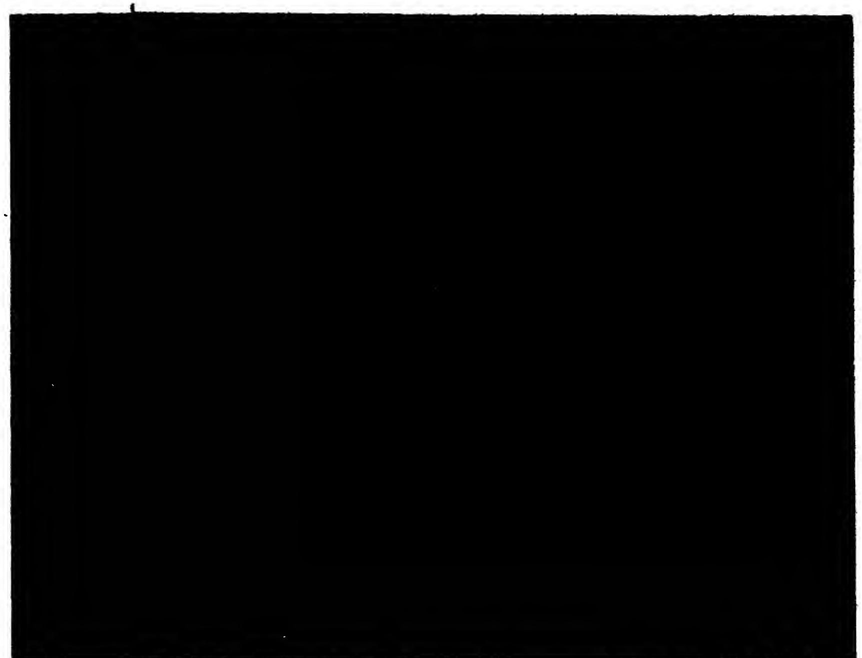
The nightingale, too, nests on the ground or but little off it. On the edge of the wood, or in the coppice or thick hedgerow, it makes a quite loose structure of which the circumference will consist of

E. Step

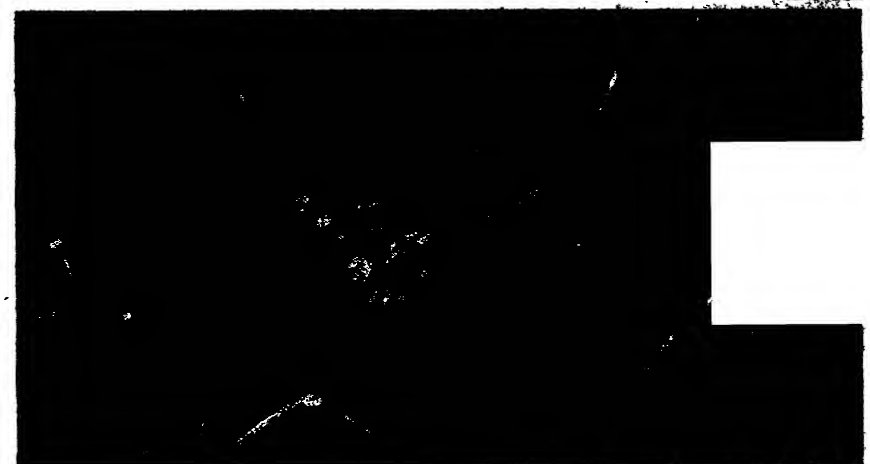
SWAN'S NEST BY THE BANKS OF THE THAMES

Swans build their nests on a large scale, of rushes, reeds and the coarser kinds of herbage. The eggs, which number from three to five in young birds and up to a dozen when maturity is reached, are laid in April or May and take well over a month to hatch. The nest seen here was photographed just below Caversham Bridge, where it stood on an island, or eyot—the favourite nesting site for Thames swans. Nine cygnets were hatched and in the nest were found an old jam pot and a bottle which had contained stout.

P Webster



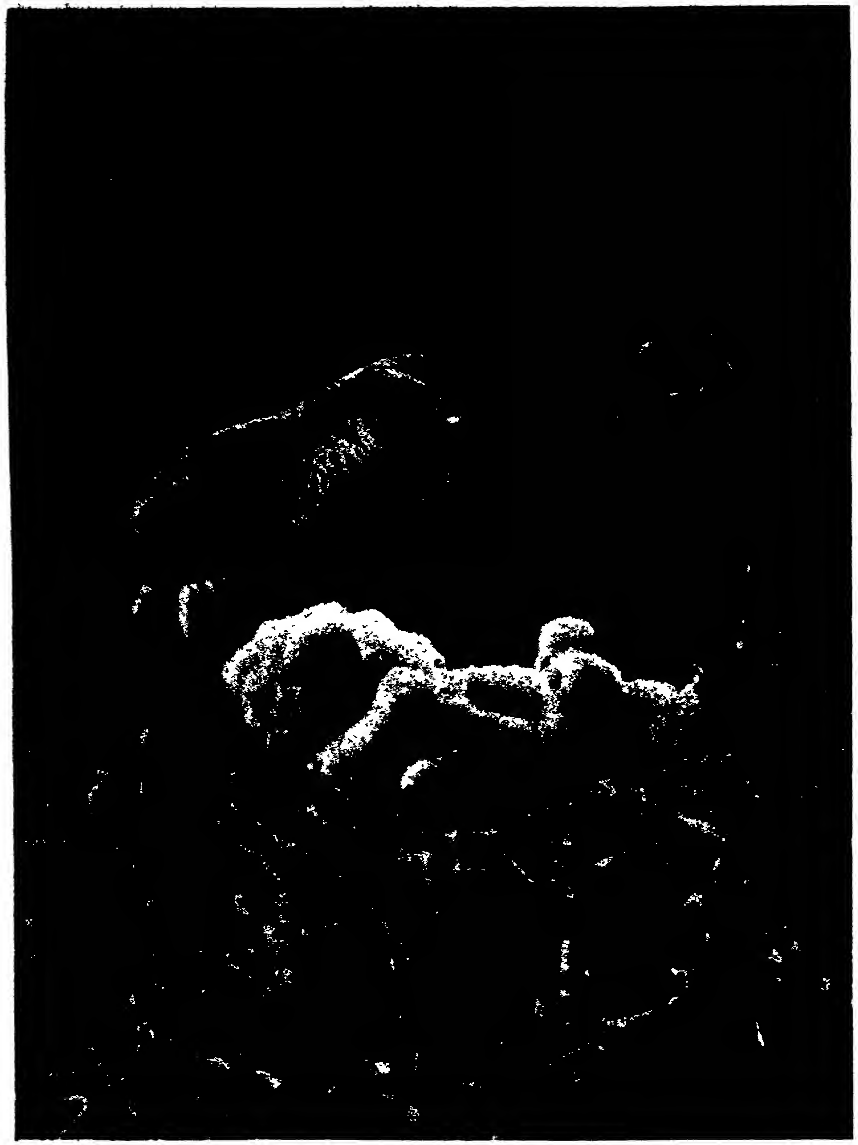
R. Chislett

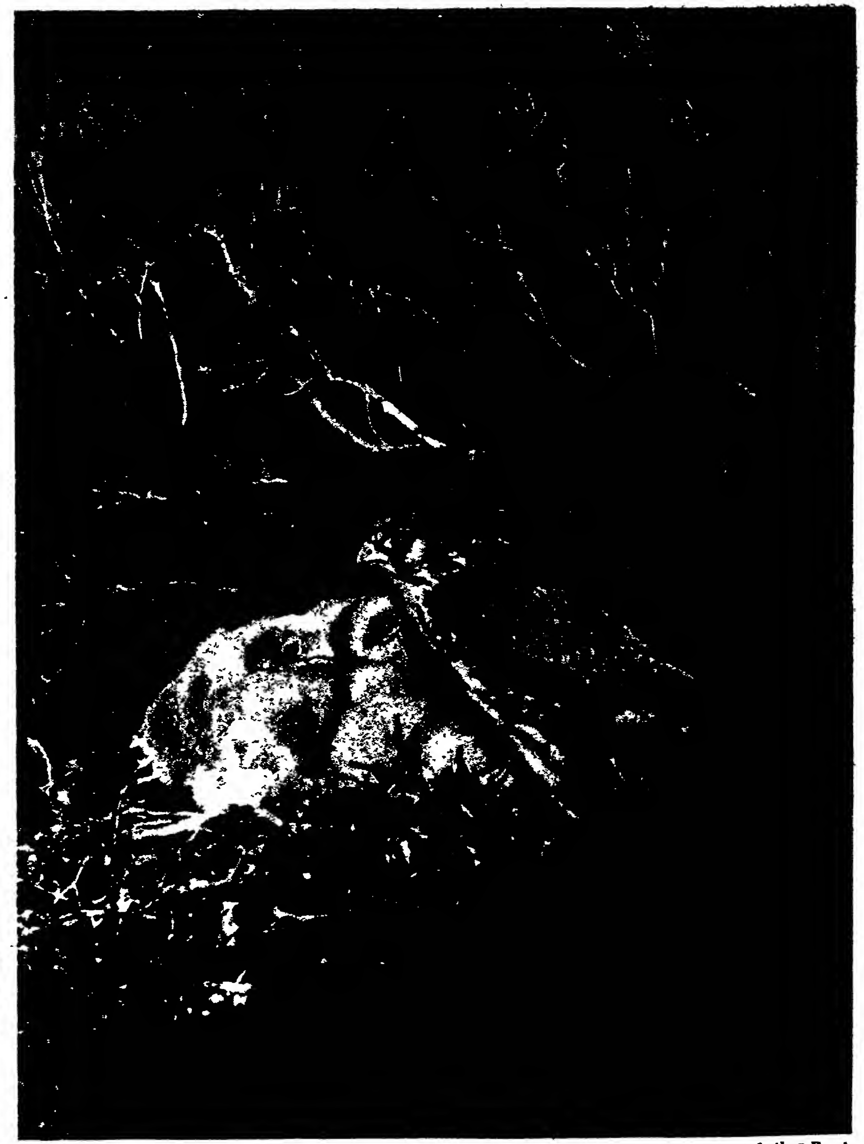


A. H. Willford

YELLOW WAGTAIL, LONG-EARED OWL, WOODCOCK AND CORNCRAKE WITH NESTS ON THE GROUND

April sees the yellow wagtail (bottom left) constructing its nest of grass and moss lined with feathers and hair or roots, in a hollow in the ground, probably in an open meadow, though there it will be wonderfully concealed. The long-eared owl (bottom right) seen above has selected a site among the bracken, and this fine photograph shows the curious barred effect of the sunlight coming between the fern stems on to the bird's back. What looks like a forest when seen from this angle (top left) is really the thick bracken where a woodcock has nested. Woodcocks always nest in the ground in thick cover and line a depression in the soil with a few dead leaves. A corncrake or land-rail (top right) often makes its nest among standing hay or corn.





Arthur Brook

BROODS OF BIRDS OF PREY: SPARROW-HAWK AND MERLIN

Arboreal in general habit, the sparrow-hawk (left) usually builds its nest on the branch of a tree which is close to the trunk. This nest is rather a rough affair of sticks outside and twigs inside, and sometimes the bird prefers to utilise the old nest of a wood pigeon. There are four or five eggs in a clutch and these are laid, as a rule, during the first few days in May. The merlin (right), the smallest of all the British falcons, just scratches a hollow in the surface of the moor where it lives and deposits its eggs—four to six—in there, seldom troubling about any kind of lining. The eggs which are of a deep brown-red or purple-red colour are laid in May.

leaves, usually those of oak, with a lining of soft material in which may be down from the seed heads of plants. The five glossy eggs are tinted dark olive. The nightingale's relation, the friendly robin redbreast, prefers a hedge bank for its not very well compacted nest of dry grass and dead leaves; but though the exterior is loose, there is a comfortable lining of hair and wool to receive the five whitish eggs freckled with red.

The blackbird and the thrush build substantial cup-shaped nests, placed in hedges, bushes and other convenient places that may offer. The builder can be determined at long range, usually, for the black-bird's nest has a more untidy exterior, with often a conspicuous loose length of straw advertising its position. Both, however, are well-woven structures of slender twigs, roots, dry grass, compacted with mud; the blackbird's lined with moss and soft decayed leaves. The thrush's is much neater altogether and, apart from the marked difference in the eggs, can be known at a glance by the smooth plastering of the inner walls with mud and cow-dung.

Arthur Brook

KESTREL NESTING IN OLD HOME OF MAGPIE

The kestrel—which also goes by the picturesque name of the wind-hover—hardly ever makes a nest of its own, but seeks out the vacated premises—empty since last year—of other birds, particularly magpies and wood-pigeons. Otherwise it lays its eggs in holes in the steep sides of cliffs or quarries.

Some of these bush-builders are less efficient as basket-makers; such is the butcher-bird, which gathers a great quantity of material but leaves many loose ends of twigs. The cup, however, is more neatly made and, being lined with soft moss, wool and hair, must be quite comfortable to the five or six chicks that emerge from the whitish eggs that are speckled with brown. Built usually in thorny hedge, among hawthorn, bramble or wild rose, it is neither easy to see nor to get at.

Similar, but neater, cups are those of linnet and greenfinch, securely hidden among the spines of furze or the pungent leaves of juniper; but much prettier ones are elaborated by the chaffinch and the goldfinch, which are more closely woven of finer material, grass and hair combined with moss and wool, decorated outside with lichens; the chaffinch lining hers with hair and feathers, the goldfinch using vegetable down for her smaller nest.

Among these small birds are some that like to have a roof over their heads when sitting and for the greater comfort of their young; so the walls of the cup are extended upwards until they form a dome over the entrance. Such structures are found on the nests of willow-warbler, wood-warbler and chiffchaff. An advance upon this style is seen in the nests of the wren and the long-tailed tit; the former a large affair for so small a bird, built of moss, grass, lichen, lined with feathers and the entrance near the top. The long-tailed tit uses kindred materials, and the nest is so decorated with tree-bark lichens that it harmonises with the branches among which it is placed. Moss, wool and spiders' webs go to the construction of the body, and the interior is made luxurious by a profuse lining of soft feathers for the numerous red-speckled tiny eggs. Neatly woven, too, is the very deep cup of the reed-warbler, though it is without a roof, and the material, the long leaves of reed and grass, so contrived that several strong upright stems of the reed pass through its walls, supporting it well above the water or marshy ground; softer material such as hair and feathers are used for lining.

Chapter LXX

Animal Marksmen Trained by Nature

By Frances Pitt

Author of "Waterside Creatures"

SOME wonderful marksmanship is found in Nature, many creatures attaining an uncanny accuracy of aim, so that they seldom miss the quarry towards which they direct their efforts.

I was thinking as I penned that line of birds that convert themselves into living bullets, the peregrine falcon that hurtles from the sky upon its prey, or the gannet which dives headlong into the sea after a fish. They are indeed marksmen, Nature having endowed them with wonderful skill. Only a short while ago I was upon an island off the Welsh coast, watching the bird life of cliff and sea, scarlet-beaked choughs upon the rocks, smart oyster-catchers tripping over the shingle, and patrolling gulls flying over the waves. Then a big white bird came into view, its large size and black-tipped primaries proclaiming it that fine sea bird the gannet, or solan goose.

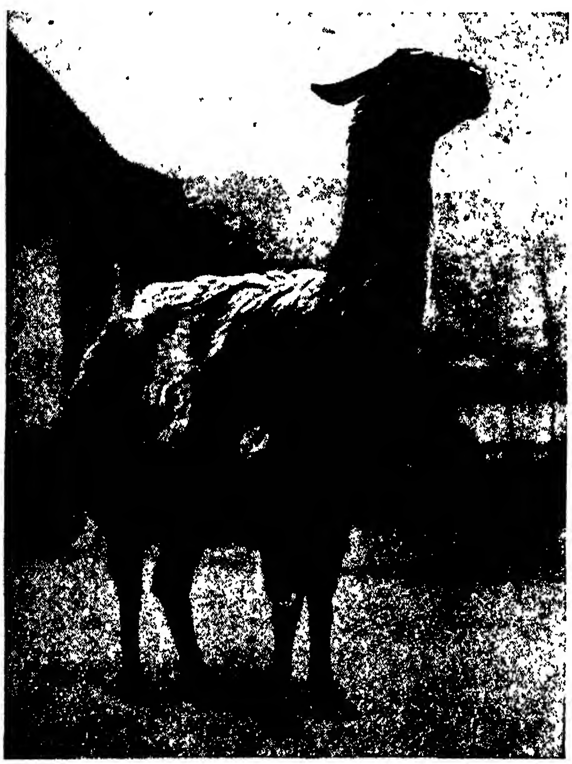
To and fro it flew, up and down the sound that separated the island from the mainland, evidently scanning the green water beneath and on the look out for a fish. It was flying at a fair height, quite thirty feet above the sea, when it closed its wings and dropped headlong, diving straight into the waves and raising a fountain of spray. It was a most spectacular plunge. The force of its dive must have carried it far under water, yet such was the marksmanship of that gannet that when it presently bobbed up to the surface it carried, as was to be expected, a fish in its beak!

There are some other sea birds that fish in a similar manner. I mean the exquisite little terns, or sea swallows. These seemingly fragile, sprite-like birds, that look as if too delicate and dainty to withstand the buffetings of life, let alone the rough waves, float about on their long white wings watching the sea beneath them, and the moment they catch sight of a little fish they plunge in after it.

I was watching some lesser terns one day (the smallest and most delicate looking of the tern tribe, mere wisps of birds that might be blown away by a rough breath) that were flying to and fro where a north country river joined the sea. The sun shone on the little white fairy-like birds, on the quiet river, and the golden sandhills in the background. As I watched them one of the terns dropped, falling as a bolt from the blue sky straight into the river—it had seen a fish! Again an accurate aim was rewarded, the tern emerging with a small fish. But as regards a living bullet what bird or beast can surpass the falcon? Marvellous indeed is the marksmanship of the peregrine, as was well appreciated in days gone by, when hawking was an everyday pursuit, and people used a falcon as they now use a shot gun. Yet before speaking of the use to which a hawk's skill can be turned, let us consider how the bird exhibits its accuracy of aim under natural conditions.

A PEREGRINE makes use of its powers of marksmanship in the following way. It gets up a good height in the air, attains its "pitch" (to use the language of falconry) and "waits on" until it sees a pigeon or some other bird beneath it, when, flying hard in the direction of the quarry, it attains great speed that culminates in a lightning dive, when with closed wings it hurtles down upon the bird, in that meteor "stoop" which the eye can barely follow. Slight indeed are the chances of the quarry, which has no time to turn and dodge. When the quarry has been knocked senseless and has fallen earthwards in less time than it takes to tell, the marksman, turning about, shoots down and upon it, to seize the victim as it lies on the ground.

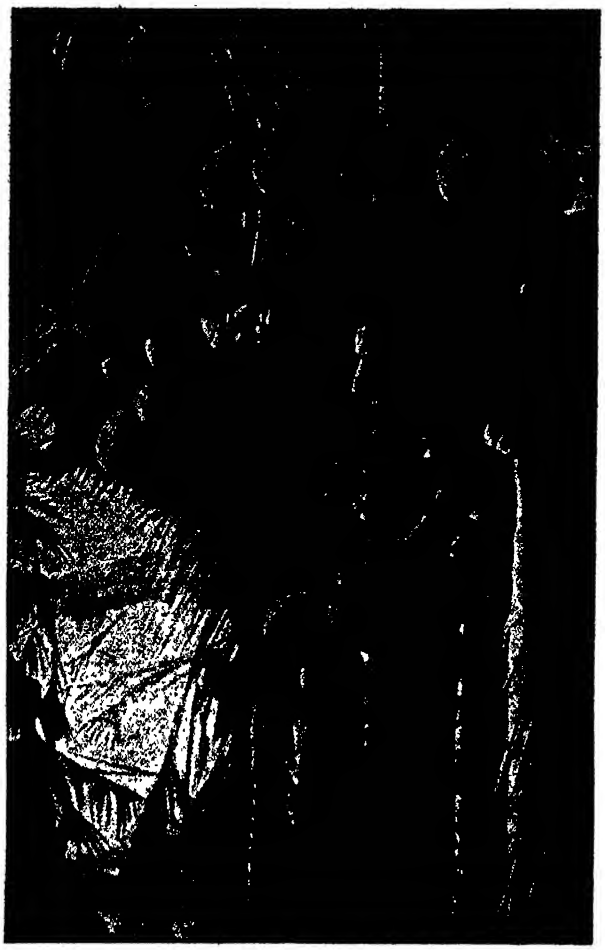
A falcon never or hardly ever grabs its quarry in the air. As it stoops upon the shifting target, it hits the bird with its clenched foot, of which the great talon of the hind toe makes a steel-like keel, and so great is this blow that the victim is generally killed in mid-air, falling in a cloud of feathers.



W S Berridge

GETTING READY TO SPIT

To spit with accuracy is a feat for which the llama inherits a special ability. Incautious visitors to Zoological Gardens have suffered unpleasantly from the results of the llama's displeasure. Here we see one getting ready to "fire."



Dr J. S. Cralnar

MONKEY MARKSMAN OF THE TREE-TOPS

Being possessed of hands the monkeys have learned to throw, a trick no other animal possesses. The monkey's habit of throwing coconuts at enemies on the ground has been turned to man's use. This monkey is trained to pick the nuts for his master.

In the days of old, as I have remarked above, this wonderful combination of wing power, accurate eye, and foot work, was brought into human service, hawks being tamed and trained and made use of, these bird marksmen exercising their incomparable skill for their masters' amusement and profit.

At this point the reader will probably enquire how far this skill is instinctive and untaught, and how far it is acquired through experience. There can be no doubt that every young hawk has an inherited aptitude to hurl itself at birds, for I have taken eyasses from the nest, hand reared them so that they were deprived of the old hawks' example, and watched their behaviour the first time a small bird flew up near them, when they dashed after it in headlong pursuit. ("Eyass" is the term that was used in olden days to denote a nestling hawk.) But though the young hawk has the desire to chase imbedded in its mental make-up, it has much to learn, and, as will be remarked later in this article, the pursuit of an unskilled eyass is a different matter for the quarry to the determined drive of a cunning old hawk, with her experience of hundreds of kills behind her.

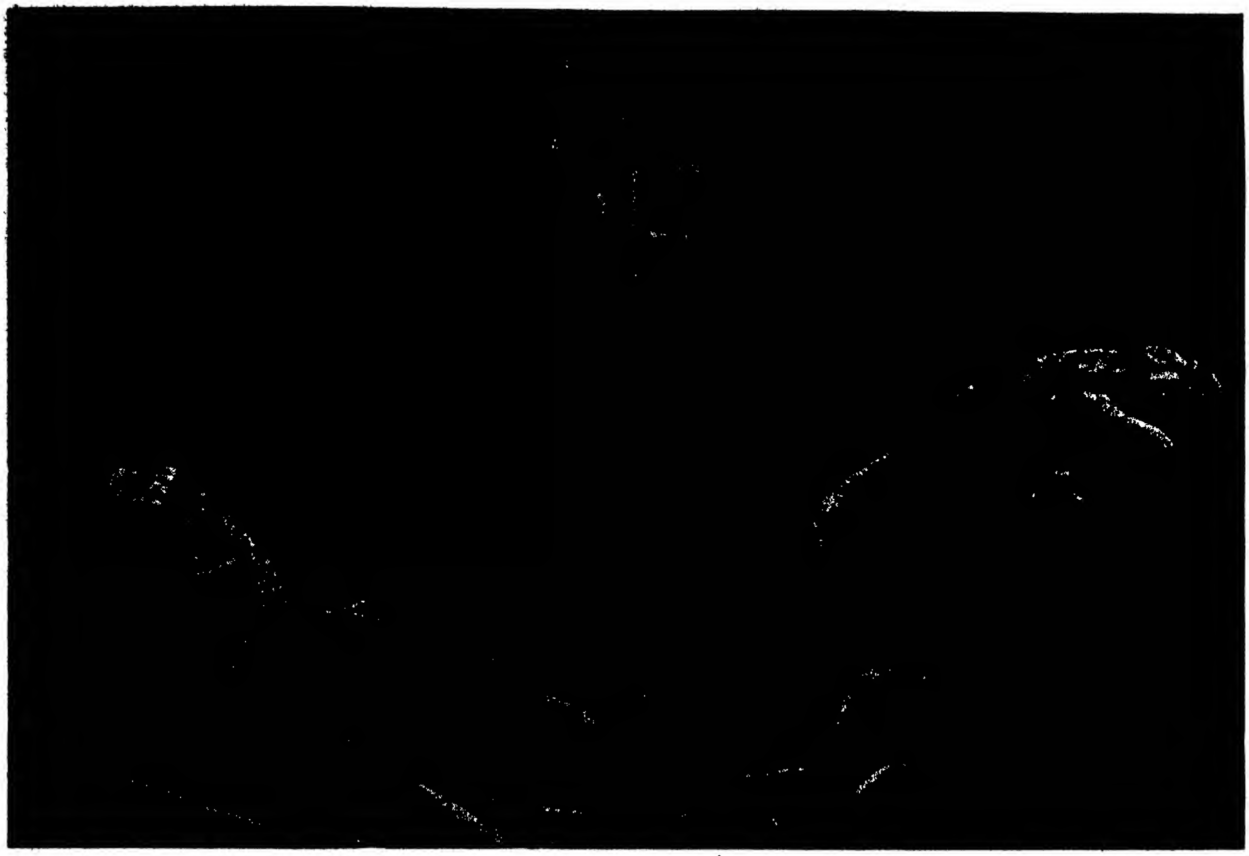
Now to turn to other skilled marksmen, whose art consists in the use of a spear, we find some fine performers among the fisher folk, to wit the heron and the kingfisher. These two most dissimilar birds have one thing in common, namely, that they make a living by spearing the fish of our rivers and brooks, but how differently they do it, though both exercise art of the highest degree.

Let us take the heron first, that lone grey bird which flaps so solemnly across the sky, to plane gently down and alight by the woodland stream, and stand tall and straight on his stilt-like legs regarding the babbling brook. Then with gentle gliding steps he walks into the water, picking his way between the green liverwort grown rocks, to where the stream deepens into a placid pool. Still he moves forward, a cautious step at a time, keeping to the shallow

W. S. Berridge

POISON SPITTING COBRA FROM AFRICA

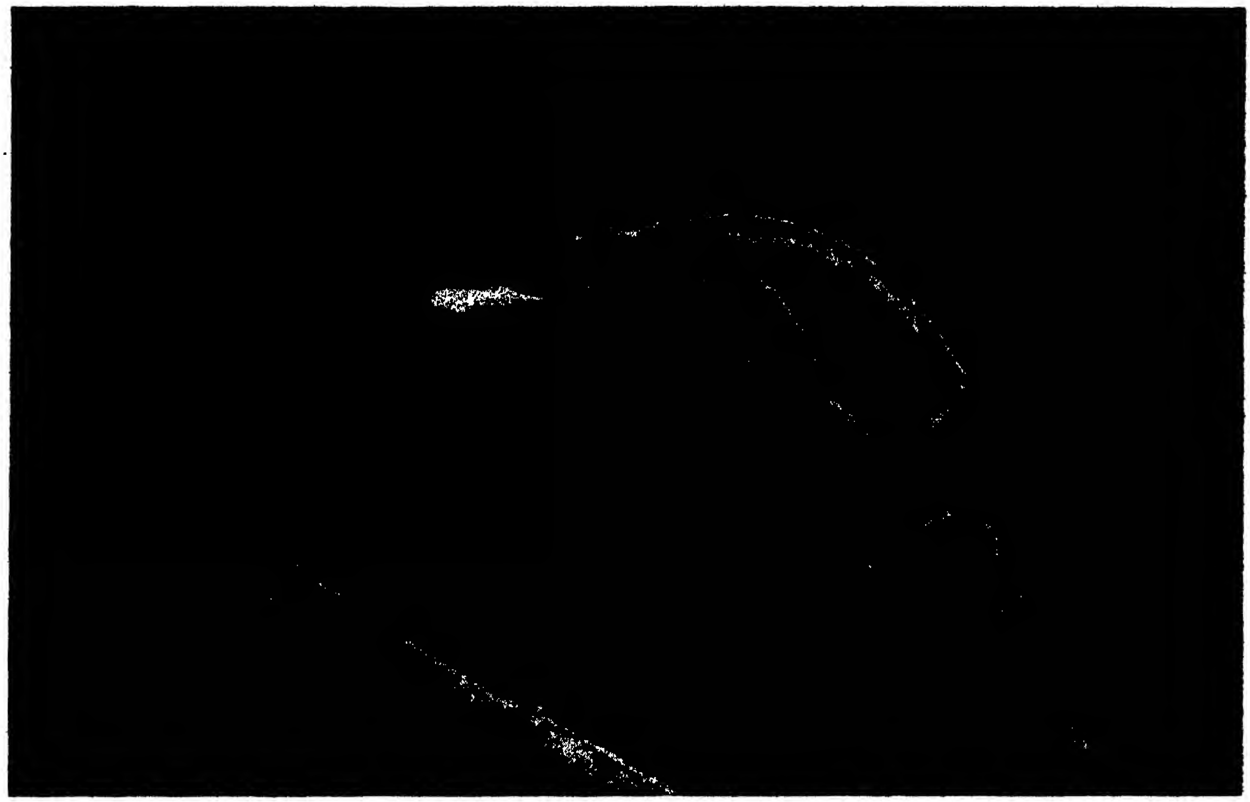
Snakes have unpleasant ways of disabling human beings, but the ringhals, or spitting cobra, from Africa is the worst. With dreadful accuracy it can project its poison into one's eye from a distance of some feet. The photograph shows it ready to spit.



James

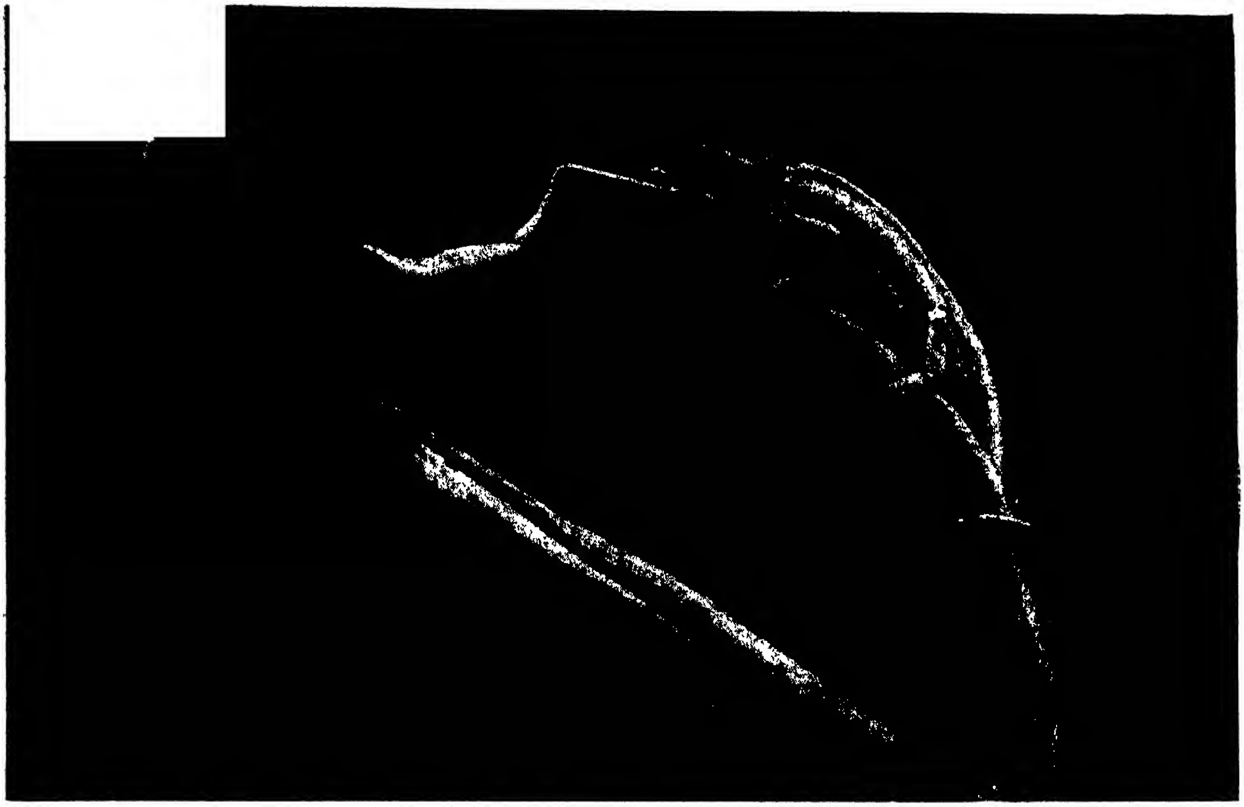
CHAMELEON WAITING THE CHANCE TO SECURE ITS PREY

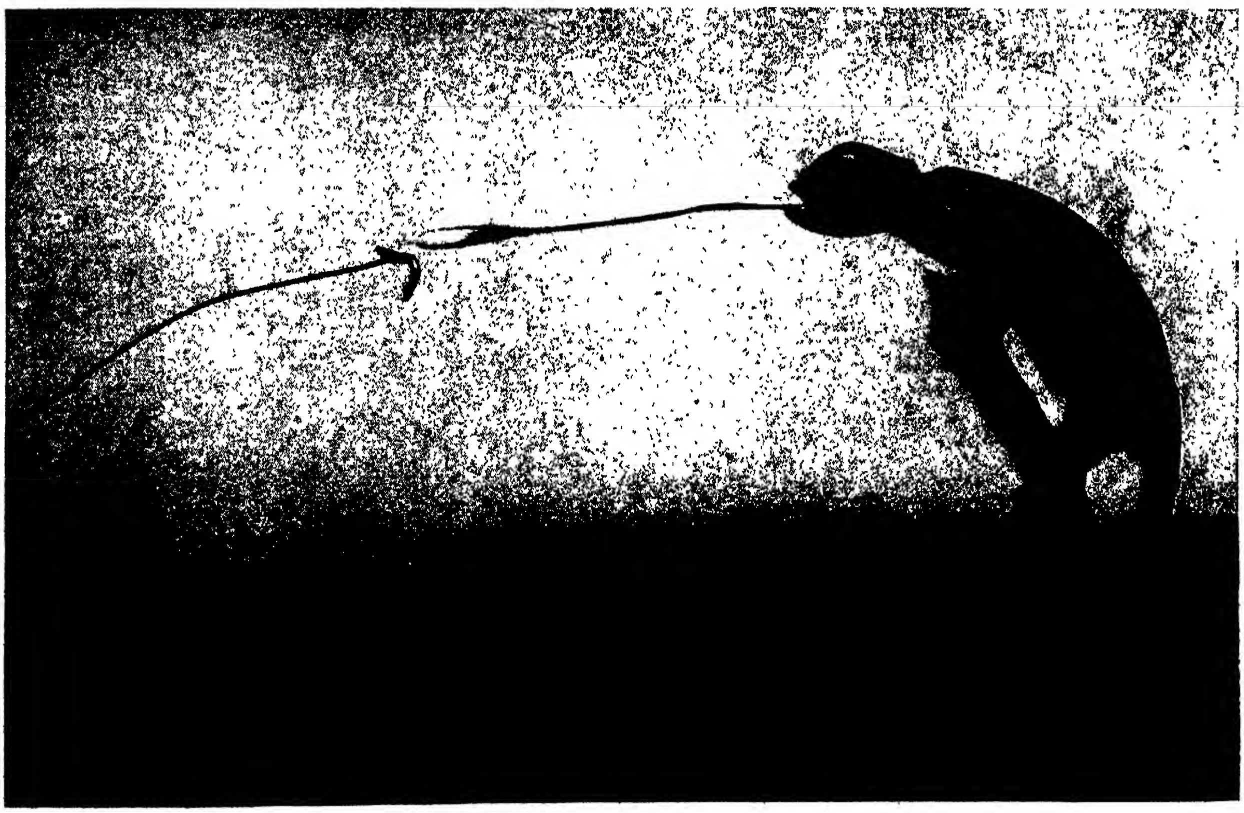
No swordsman ever achieved so rapid a thrust with the rapier as the chameleon achieves with its long and lightning tongue. Here (bottom) we see the position taken up when the animal is about to secure an incautious insect. The tail is coiled securely round a branch and the tongue is just beginning to come out from between the jaws. The upper photograph shows a group of these creatures upon a branch, meditating over their last meal and the possibilities of the next. Notice the different postures.



CHAMELEON PREPARING TO SHOOT ITS TONGUE AT AN INSECT

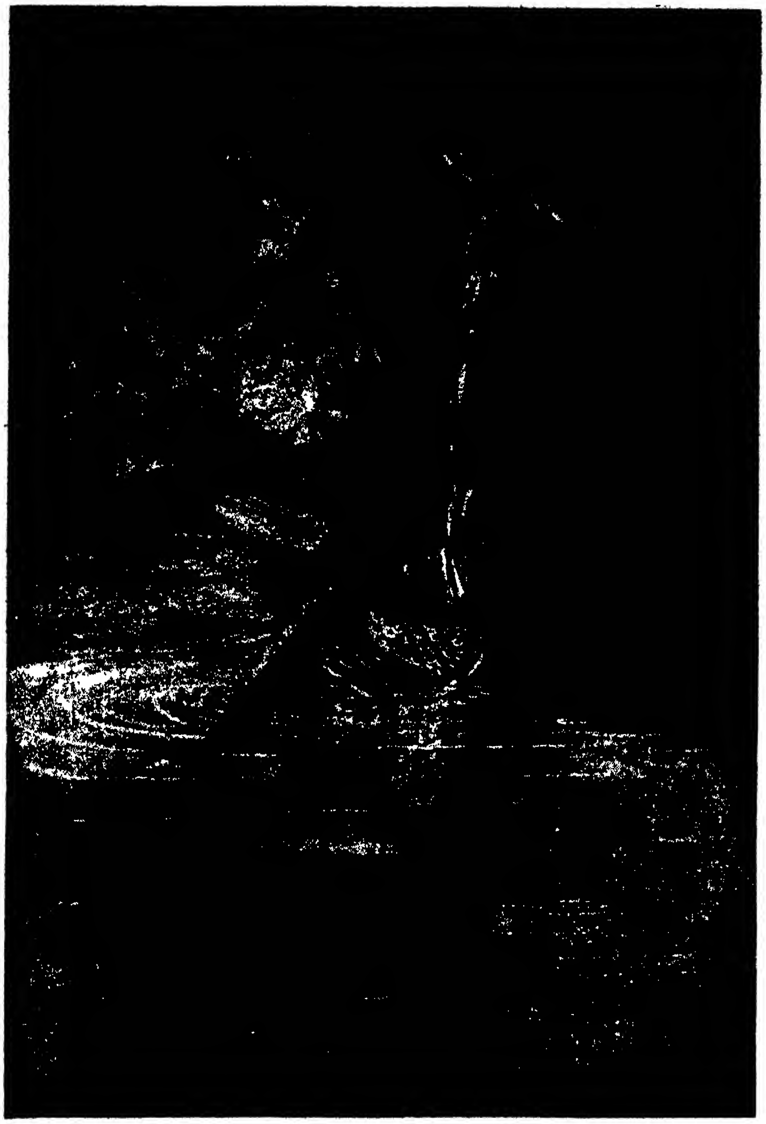
When not in use the chameleon's most remarkable tongue is folded away within a special sheath which is located in the dilatable skin of the chin. The little reptile remains immobile for hours on a branch until some fly or other insect settles within range. Then the chameleon, rolling one of its eyes—which work independently of each other—until it has focussed on its intended meal, protrudes the fat tip of its tongue from between its jaws, takes aim and then, with a movement too quick for the eye to follow, the tongue flies out and the insect is struggling on the end. The end of the tongue is covered with a sticky substance.





REMARKABLE TONGUE OF THE CHAMELON IN OPERATION

Only the camera can record the different stag ... at an insect. Compared with the size of the little reptile th ... The true home of the chameleons is Africa and the adj ... and India. They are not difficult to tame if allowed to become used to new quarters in peace, and will live in a greenhouse, where the wonderful action of the tongue can be studied at leisure as long as there is a supply of flies available.



ARCHER FISH AND ITS INSECT TARGET

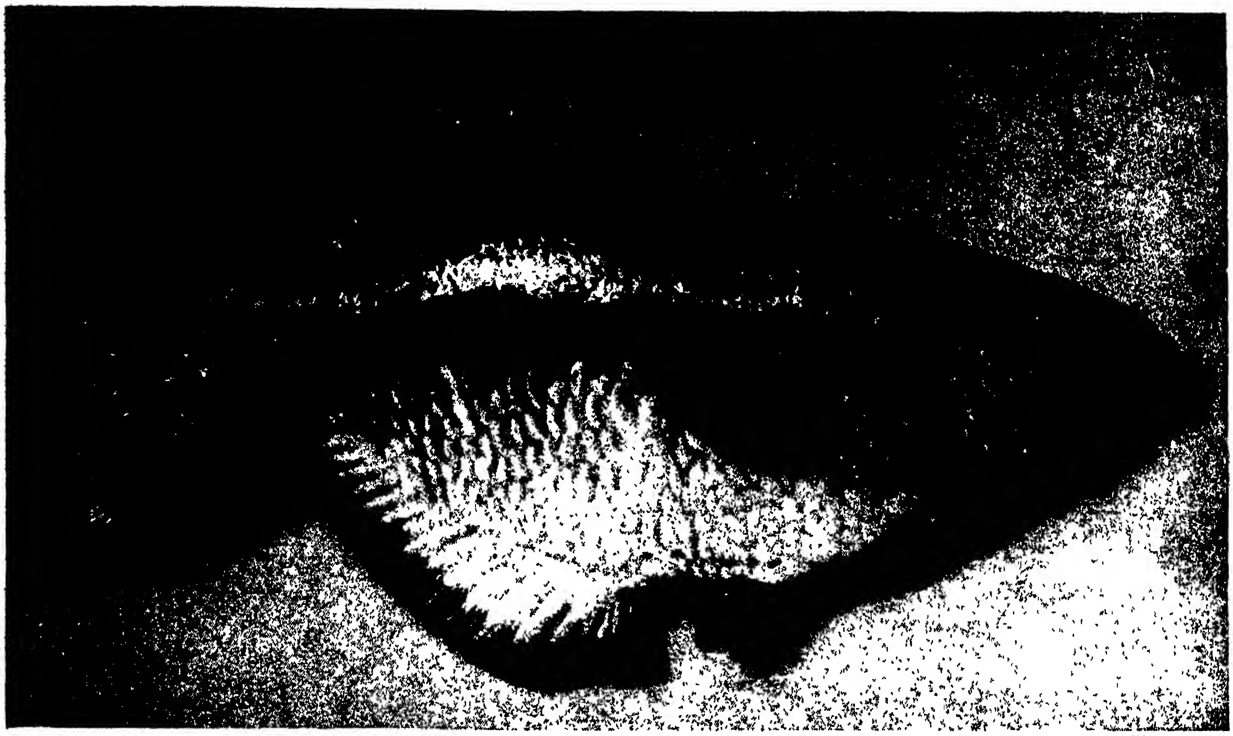
This drawing depicts the method by which the archer fish obtains an insect that would otherwise be out of reach. It takes water into its mouth and spits a large drop into the air, aiming so accurately that the drop strikes the insect and knocks it into the stream, when the fish can easily snap it up.

water and scanning the current with keen yellow eye. Hardly moving, looking more like a grey stick than a living bird, he stares and stares—a shadow in the water, the heron's beak flashing quicker than the eye can follow, and the fisherman has speared a trout. It gleams for a moment in his yellow beak, its spotted sides distinct, then by some sleight of hand (or rather of bill !) he turns it about, so that he holds it head first, gives a gulp, and all that remains of the fish is a lump sliding down the heron's grey neck. He remains quiet and thoughtful for a moment, then gives himself a shake, looks about and wades forward ready to spear another trout.

And what of the heron's competitor, that other expert with the spear, namely, the kingfisher? Well, his methods are different, but equally efficient. Here he comes, darting down the watercourse, flashing by like an electric vision on the wing, a dazzling flash of blue-green light that makes the observer blink, and marvel that such gorgeous colouring should appear in the sober landscape of a European river.

Such hues are tropic in their intensity. But for all his beautiful plumage the kingfisher is no amateur at his trade. He turns aside, darts up to a branch that overhangs the river, and vanishes. He is there all right in reality; he has but turned his chestnut breast to the river and the observer, and his iridescent blue-green back to the overhanging trees. Thus, the kingfisher sits, perfectly still, scanning the flowing water passing beneath, and watching for minnows and little trout. Suddenly he dives headlong in the stream, raising a shower of spray, from which he rises, a small fish in his beak, to fly back to his perch. He beats the fish on the branch, thumping it until it wriggles no more, when down it goes, head first.

So far we have been discussing birds that are skilled marksmen in capturing their quarry, but what of creatures that aim in aggression or self-defence ? Under the former heading we must place the llama, and the latter the fulmar petrel. Both have the unpleasant accomplishment of being able to spit straight at a mark. For this reason it is well to beware when visiting the llama house at the Zoo, as these animals can and will spit at people who do not please them. Whether this ability was useful to the llama and its wild relatives in its South American home is a question I cannot answer, but undoubtedly the fulmar petrel benefits by its mastery of the art of spitting. The fulmar petrel, a graceful sea bird, white, with greyish mantle and wings, was once confined to the lonely island of St. Kilda out in the Atlantic, but has spread and increased, so that it now occurs on the great cliffs of the Orkneys and Shetlands, and even upon the Scotch and English coasts. Very lovely it is to watch, so graceful and dove-like upon the wing, so soft and motherly as it broods its solitary chick on some ledge of a tall cliff with the waves thundering far below. Of all gentle creatures it looks the most inoffensive, and so it is—as long as it is not disturbed, yet the person who incautiously approaches the brooding bird is likely to receive the oily fishy contents of its crop full in the face !



W. S. Berridge

SKILFUL ARCHER FISH OF EAST INDIAN AND AUSTRALASIAN WATERS

From the East Indies, Northern Australia and New Zealand comes the archer fish which haunts estuaries on the look-out for flies. A number of fishes have resorted to the habit of leaping bodily out of the water to get their food, but the archer fish has improved on this method by turning its mouth into a kind of blow-pipe as illustrated in the opposite page. This is a very thick-set fish with the spiked dorsal fin placed far back. It can spit with unerring aim to a distance of about five feet.

To return to animals that use their marksmanship to gain a living, the common, familiar frog is not a creature that would be expected to have a " straight eye " or be good at hitting a mark, yet it can aim well, and shoots with its tongue. It is fond of insects and small grubs, coming out to look for them in the twilight. It stalks them carefully, getting as near as it can, then out shoots its tongue, hits the fly or grub, and being sticky at the tip retains the victim, which is drawn back to be munched up, when its captor goes on and looks for another.

The chameleon practises the same art, but it does not go and look for things, instead it waits for flies to come to it, sitting immovable for hours until some unwary insect wanders within range, when out goes the tongue and in comes the fly. The lightning flash of that elastic, but deadly accurate, tongue issuing so suddenly from the seemingly lifeless little reptile is one of the many amazing things in Nature.

At this point it will probably be asked whether any animals use weapons with which to hit a mark, or whether the use of weapons is purely human ? Monkeys may at once be cited as using stones, sticks and nuts, to throw at foes, picking them up and hurling them with a considerable degree of precision. In Professor Kohler's " Mentality of Apes " we find a most entertaining description of chimpanzees employing sticks as weapons, but chiefly in play and mock warfare, when they used a staff quite effectively. The writer, however, makes no mention of his monkeys throwing their sticks at anything, but only refers to the weapons being brandished and used for hitting objects, including the other monkeys. Yet some of the smaller monkeys throw sticks and nuts quite freely and with an accuracy most unpleasant for the target. But then their hands are well adapted for grasping and throwing, as indeed are those of all the higher apes.

In considering the marksmanship of mammals other than the apes, it must be remembered that the use of weapons is debarred them. They have no means of using them. It takes a hand to grasp a stick or a nut. In considering human achievement, how much do we owe to our efficient hands ? Perhaps the human brain would have overcome the handicap of less efficient members, but it is certainly the hand, with its thumb and fingers, to which we owe our mastery of the world, to say nothing of the art of throwing things and aiming accurately at a mark. Hence it is that we have to turn to the monkeys, with hands somewhat of the pattern of our own, to find even limited ability in throwing things. Most other creatures have to turn themselves into a missile. The falcon, already spoken of, is a good example of a living bullet, when it hurtles down from the heavens on a pigeon or other bird. Crocodiles aim with their tails, using this appendage to sweep the

E. N. A.

WHIP-RAYS SPEARED ON A BEACH OF NORTH-WEST AUSTRALIA

From time to time there have appeared before the public certain men who were such experts at using a stock-whip that they could flick the ash from a cigar without touching the smoker between whose lips the cigar was held. The whip-ray has developed a tail much like a stock-whip save that the end is armed, in some cases with a poisoned sting, and in others with a sharp spine, either weapon being very deadly in execution. Here are a number of these unpleasant creatures which have been speared by some natives of north-western Australia.

victim off its feet; horses strike with their feet, kicking in aggression or self-defence; the giraffe, too, can give a shrewd, well-aimed kick at anything attacking it; and then there are the members of the cat tribe, the household puss, lion, tiger, and so on, whose marksmanship consists of accurately springing or hurling themselves upon their quarry.

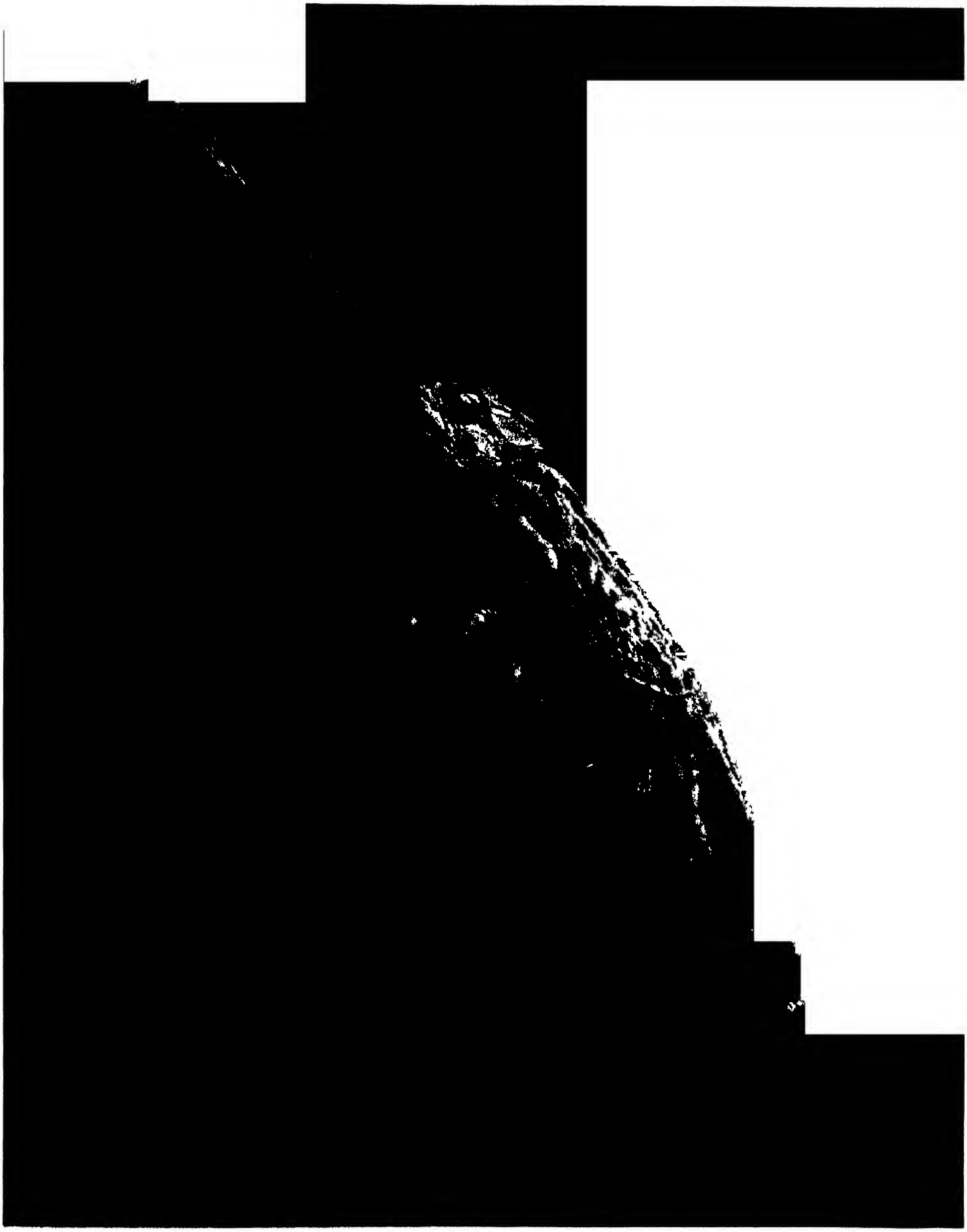
Apropos of the tail being used to hit things, perhaps the most remarkable development of this special branch of marksmanship is that found among the sting-rays. The sting-rays are fish allied to the sharks and skates, but of weird aspect, most species having a flat, bat-like body with a long, thin tail, the latter being like a whiplash. This whiplash is, however, a most efficient weapon, being armed in some cases with a poison spine, that deals death to the victim, and in others with a serrated dagger that is equally deadly and efficient.

But writing of marksmanship among the fish, the first prize-winner for real skill, even if that skill be an inherited aptitude rather than acquired art, is undoubtedly the archer fish. This fish, found in Java and Sumatra, has the extraordinary habit of spitting at insects sitting on the leaves and twigs of trees overhanging the water, and thus knocking them into the river, where they are easily accounted for. It does not aim directly at its quarry, but over it, so that the drop falls upon the insect from above, and knocks it off its resting-place.

To jump from fishes back to the higher mammals there is the elephant, which is no mean exponent of the art of "shooting straight," that is, when there is a supply of water at hand and it can fill its trunk and blow the contents with some force in the desired direction.

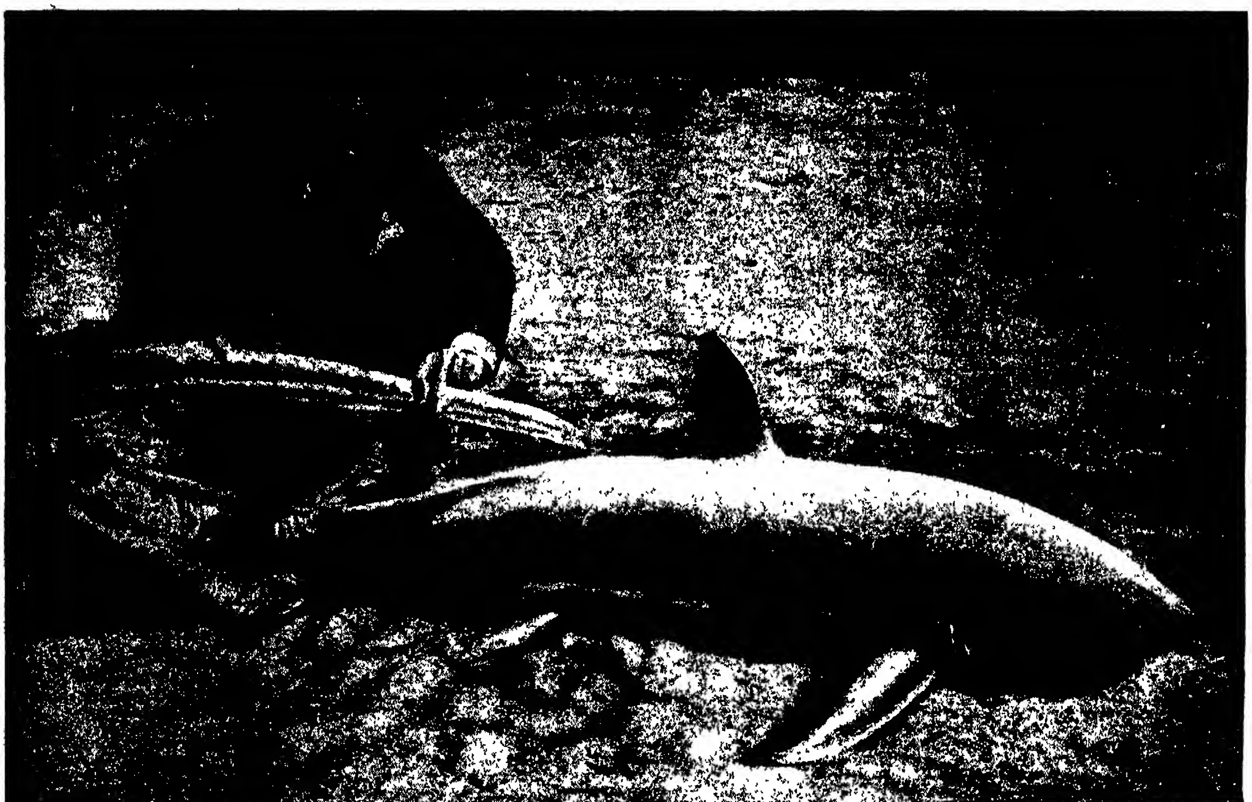
ONCE, at the London Zoo, I saw two men teasing an elephant in the Elephant House by holding a bun towards it and snatching the offering back just as the animal was going to take it. This went on for some minutes, until the elephant, evidently realizing it was being fooled, swung on its heels, and went to the back of its stall. Here there was a tap, from which water fell in slow drops. The elephant placed the tip of its trunk beneath the tap and stood for some time collecting the dripping water. Then it turned about.

The young men were still there watching the elephant, but had evidently no expectation of what was about to happen, though an instant later they were able to appreciate how accurately an elephant can aim. Up went its trunk, and out shot the water. Straight it came into the faces of the culprits, running down their necks, and all over them. They decamped in a hurry amid the jeers of the onlookers, while the elephant watched their inglorious departure with a satisfied air. Certainly it had managed to hit its target all right!



CHAMELEON, A FINE MARKSMAN, "SHOOTING" ITS PREY

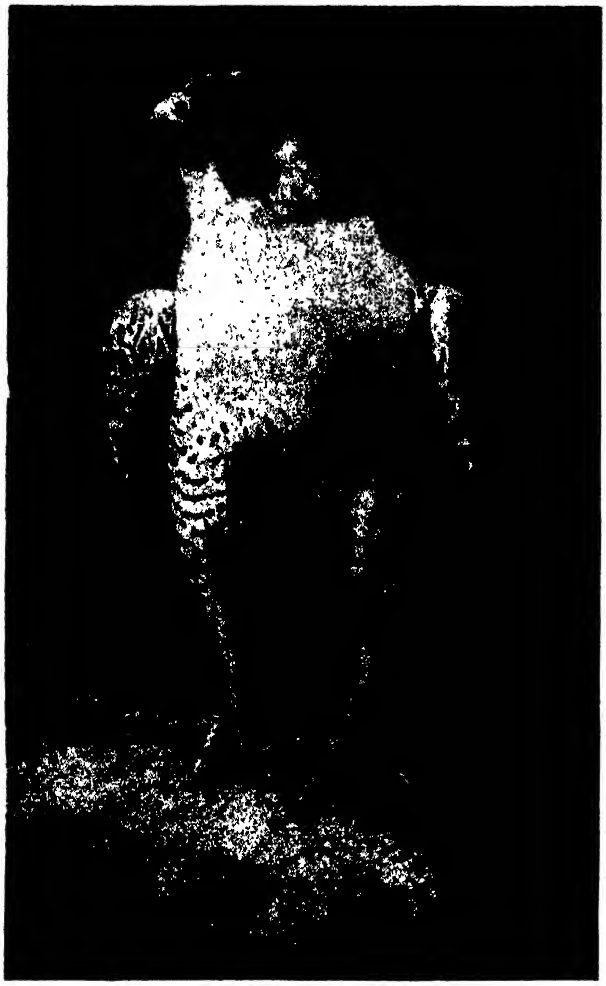
With its tail curled securely round the branch on which it stands, the chameleon takes careful aim at a fly which has just settled on a leaf some inches above the little reptile's head. Then comes a lightning movement, too quick for anything but a camera lens to follow, the long tongue shoots out, hits the fly unerringly and, by means of its sticky end, secures the chameleon another meal

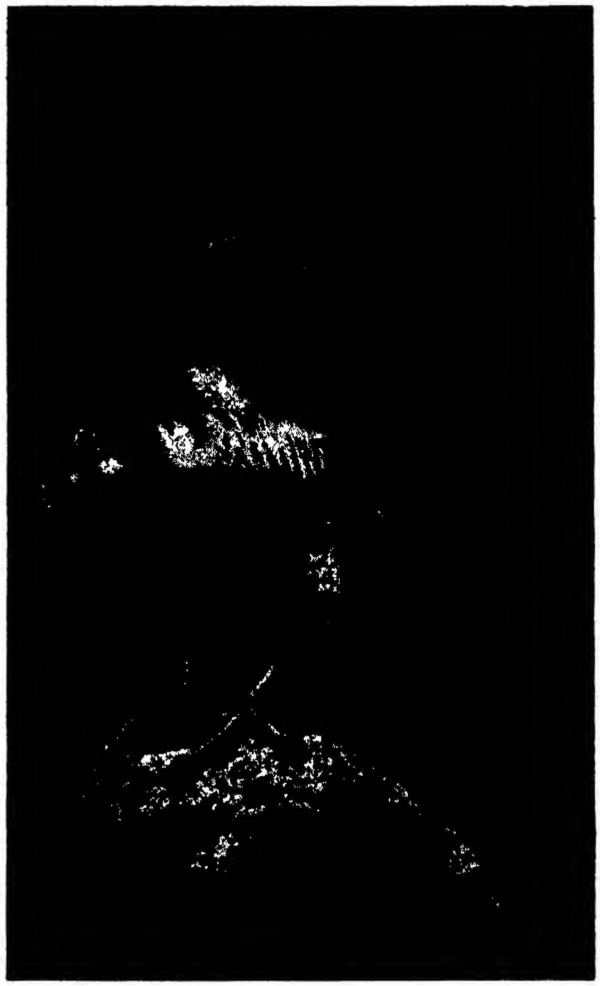


W. S. Berridge

THRESHER OR FOX-SHARK WITH A HIGHLY SPECIALISED TAIL

Threshers, also called fox-sharks, feed on fish that swim in shoals, such as herring and mackerel, and obtain their prey by swimming round a shoal, threshing the water with the tremendously developed upper lobe of their tail fins. The shoal is in this way induced to take up a more compact formation when the thresher can the more easily dispose of the frightened fish. Threshers are also said to attack whales by lashing them with these long tails. Below is a photograph to show the action of the tail, and above is a specimen caught in a net.





E. J. King

PEREGRINE FALCON THAT TURNS ITSELF INTO A LIVING BULLET

In its huntingt he peregrine flies upwards until it has attained what is called its "pitch" and then "waits on" till it sees some suitable prey flying below. It sets off in pursuit and, judging the distance and its own and its quarry's speed to a nicety, shuts its wings and falls like a stone. The impact when the peregrine strikes its mark is calculated to kill even a large bird, the fatal blow being really a kick with the clenched claw, which is armed with a murderous talon on the hind toe.

Elephants are exceedingly skilful in shooting thus at a mark. But whether their skill could be greatly enhanced by suitable training is another matter. Probably it could, because however complete the instinctive outfit of any creature, it is obvious that practice helps it to co-ordinate eye and muscle and improve its performance. This is why play is of such importance in the life history of birds and beasts, the playful repetition of actions smoothing out hesitations and imperfect correlations, so that when the need arises the creature can behave appropriately with the perfect response of much practice, to say nothing of confidence in itself.

I have described at some length that living bullet the falcon, which hurls itself from the sky with unerring aim at its quarry below, but as was pointed out at the beginning of this article, the young and inexperienced hawk has to acquire that skill. It has a feeling, a "notion" for the work, otherwise an instinct to stoop at birds, but it only attains the perfect skill of its parents after many days of play with its brothers and sisters and of unsuccessful attempts to capture birds.

What a fine sight is afforded by a party of peregrines, the young birds swooping, turning, wheeling and diving, driving at one another from aery heights, dashing up again into the blue, and practising, in the joyous light-hearted abandon of the young, every trick of the wing that will lend them mastery of the air and endow them with the strength, to say nothing of the certainty of eye, to dart from the clouds with the unexpectedness and velocity of a meteor and strike a mallard or grouse headlong into the heather.

Thus we see that the ability to hit an object, in one word, "marksmanship," is of supreme importance to a number of wild creatures, and that the skill of the finished master is in many instances only attained after a more or less lengthy apprenticeship.

Chapter LXXI

The World of Make-Believe

By W. P. Pycraft

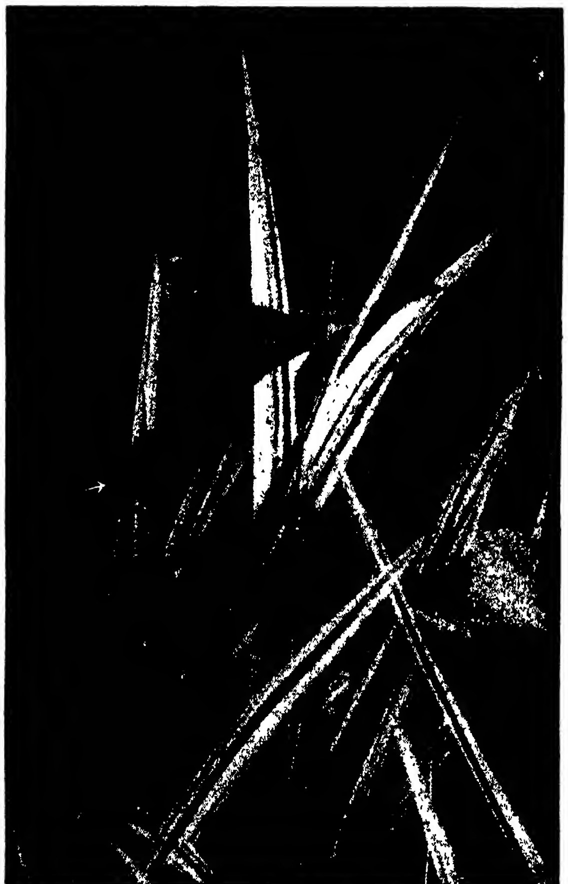
Author of "Camouflage in Nature"

ALTHOUGH a vast mass of material has been garnered bearing on the theme of the coloration of animals, there is, as yet, an immense amount of work which must be done by observers in the field before we can penetrate further into some of the more puzzling aspects of coloration where this is associated with behaviour which seems to imply a conscious exploitation of bodily peculiarities of colour and structure. And this, too, where we should least expect to find it—among lowly creatures like insects, crustaceans and molluscs.

In surveying cases of this kind we have also to consider, as might be expected, a number of "borderline" cases, and these should be very carefully examined for they may afford a clue to the more complex instances presently to be reviewed.

In Chapter III of this work mention was made of caterpillars which have acquired an extraordinary likeness to twigs of the plant on which they live; but this likeness holds only so long as they behave like twigs; that is to say, so long as they stand out stiffly and absolutely without movement, an attitude which they must maintain throughout the whole of a long day. We have no reason to suppose that they are afraid to move, but rather may safely conclude that they have become adjusted to feeding by night. Nevertheless, we cannot help asking what agencies have been at work to change so materially form, coloration and habit, and to blend the results together to produce this startling likeness between a living body and a "dead" twig.

No less remarkable is the case of caterpillars of the small moths of the family Psychidae. They are known as basket-worms, and this because they live in curiously wrought tubes recalling those of some species of caddis worms. In one species this case is made of short rods of wood, arranged in the form of a spiral; another, Helichopsyche, spins a case of silk so like that of a snail-shell in form and texture that specimens have actually been sent to the British Museum as snail-shells! We cannot for one moment suppose that one of the caddis-like caterpillars had deliberately imitated the case of the caddis worm, for it would be useless to imitate the semblance of an aquatic creature climbing about on land: nor is it any more likely that the other imitated the shell of the snail. These two cases of resemblance are purely accidental; but they are none the less puzzling.



J. J. Ward

BUTTERFLY MAKE-BELIEVE

While its enemies are busily searching for their food the green-veined white butterfly is pretending, with wonderful success, to be part of the blade of ribbon grass on which it has settled. How closely it harmonises with its background may be seen.

THE art of make-believe, again, is practised by a large number of very different types of animals which in face of peril feign death. And in some the whole form of the body seems almost to have been shaped to lend colour to this piece of deception. The stick-insects, for example, even while they are at rest are hardly to be distinguished from among the surrounding twigs. Remove one from its hiding place and hold it in the hand, or lay it on the ground. Throwing the legs straight forwards to continue the line of the long, slender body, it remains absolutely motionless for a minute or two. Then, when it seems to imagine the enemy has gone, it slowly gets up and walks away! This is a well-known trick of the opossum—hence the phrase "playing 'possum."

The land-rail, again and again, has deceived sportsmen in this way. Taken but slightly wounded and brought by the dog to its master's feet, it may be held in the hand apparently lifeless, with head, neck, and legs dangling limply but if presently put down on the ground it will slowly raise its head as if to see whether the coast is clear, then instantly dart off. Its cousin the water-rail is no less

H. Bastin

a peculiar aptness to assume a likeness to foliage. The wonderful case of the butterfly Kallima has already been cited in Chapter Three. But surely the case of one of the British butterflies is no less striking. This is the Duke of Burgundy fritillary, wherein the caterpillars, just before passing into the chrysalis stage, group themselves together in little clusters of three or four at intervals along a stem of the food-plant, so that when they have finally assumed the chrysalis condition they take the form of a series of leaf-buds.

Yet this astonishing behaviour is surpassed by one of the hemiptera, *Flata nigrocincta*, a species which has no name in common speech. The

skilful in playing the "artful dodger." When we find this ruse practised in highly organized vertebrates we interpret the behaviour as due to a fairly well developed "emotional complex." But it is by no means so easy to understand precisely similar conduct on the part of insects whose brain is known to be of an exceedingly simple type.

Birds will also on occasion feign wounded, as when they desire to draw away men or other formidable enemies from the vicinity of their young. By affecting a broken wing the bird induces the enemy to give chase, and with the prospect of an immediate capture. But as soon as a sufficient distance is judged to have been placed between the "wounded" one and her young she flies off, and leaves the young to save themselves by scattering and trusting to their protective coloration.

Behaviour of this kind we never meet with in the more lowly types such as the insects, for they rarely take any active part in the care of their young. But we cannot avoid taking these cases of the behaviour of birds and beasts into account when we are considering a like behaviour on the part of, say, the stick-insects. The butterflies and moths seem to show

J. J. Ward

INSECTS IMITATING LEAVES

While some creatures make believe to be something else to save themselves from being eaten this group, representing four of a species of mantis from tropical America (bottom), imitates a bank of leaves in order to be able to eat. Some unsuspecting victim will pay with its life for its mistake. Above is a Ceylon green leaf insect.

record of its strange story we owe to Professor Gregory, who, during his exploration of East Africa, found himself one evening in the woods by the Kibwezi river when his attention was attracted by a large, brightly coloured flower—like a foxglove, and below the inflorescence he noticed some small, white, fluffy patches, apparently of a lichen which does not usually grow on flower stems. To examine these further he tried to pull the flower-head towards him with his stick, when, to his amazement, the "flowers and buds jumped off in all directions"!

He waited till his friend just behind him came up, when, pointing to some similar clusters close by, he quietly asked him if he knew to what genus they belonged. The friend replied that though he had seen them before he had never examined them, and at once put out his hand to pluck a specimen. The moment he touched it the same uncanny destruction of the "flower-head" took place.

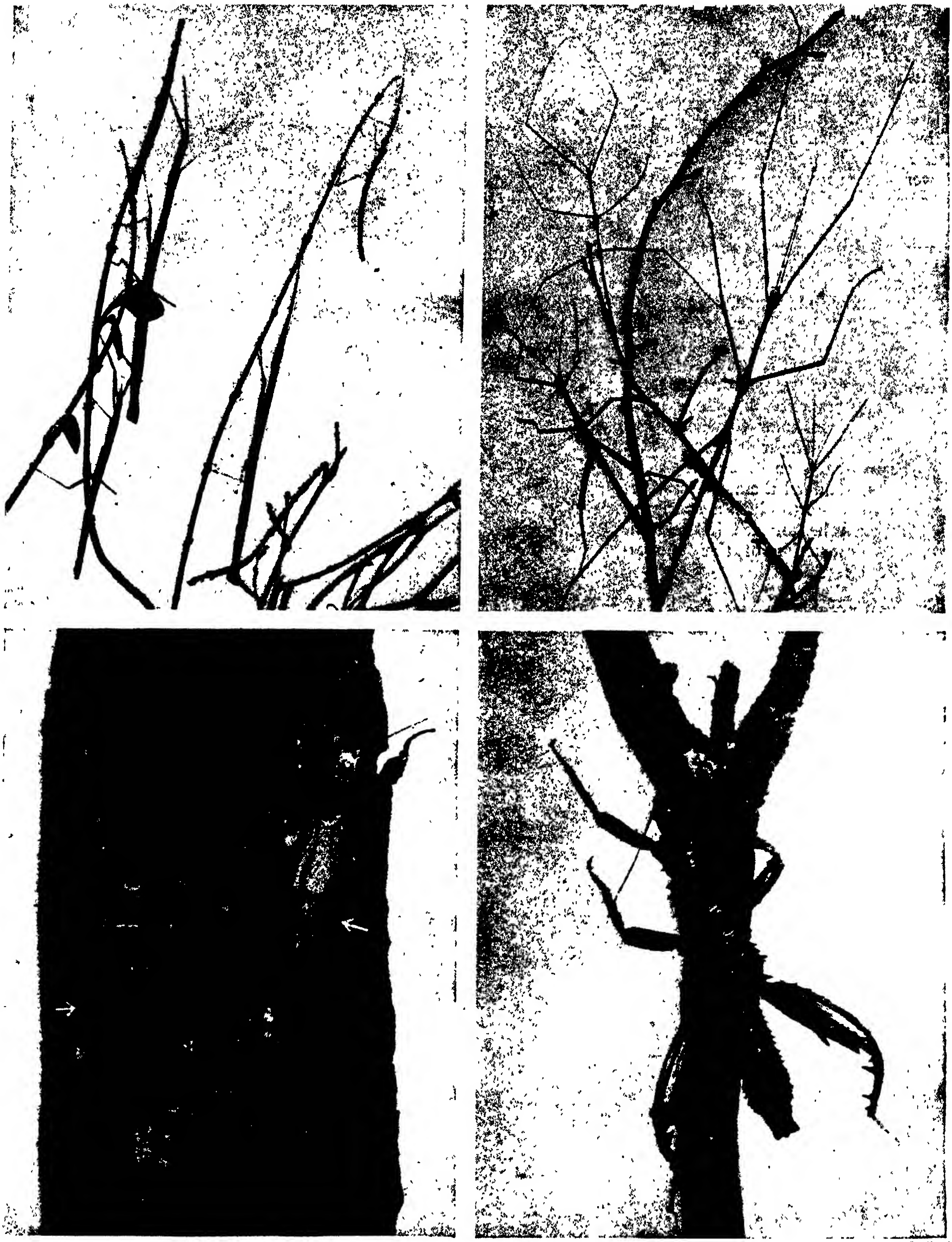
In the arrangement of this "flower-spike," the green bud-like forms were at the top of the stem and the pink flower-like insects below, while the tufts of apparent lichen turned out to be the larval stage of the same insect, but of a younger generation. The members comprising the "flower-head" then are "dimorphic," that is to say, they present two forms, one green and one gaily coloured. But we are still at a loss to know what determines their resting positions, for we can scarcely suppose that they deliberately sort themselves according to their coloration before settling down. Professor Gregory, in the hope of discovering an answer to this riddle, waited for some time to see whether they would return and take up their original position, but in this they disappointed him.

Yet one more case of insect behaviour which seems to show a conscious effort to deceive. This is furnished by a black and white West African moth, *Deilemera actinorii*. When spinning its cocoon it covers the outside with little whitish

H. Bastin

FLYING INSECT PRETENDS TO BE A ROTTING TWIG

With wings spread the insect dnomotis is palpably a flying creature going about its business, but when it settles (top) it ceases, apparently, to be a living thing at all and becomes a piece of decaying twig. As it chooses its alighting places to suit its own peculiarity, dnomotis is hard to find when at rest. It is difficult to believe that a flying thing could look so dead.



J. J. Ward

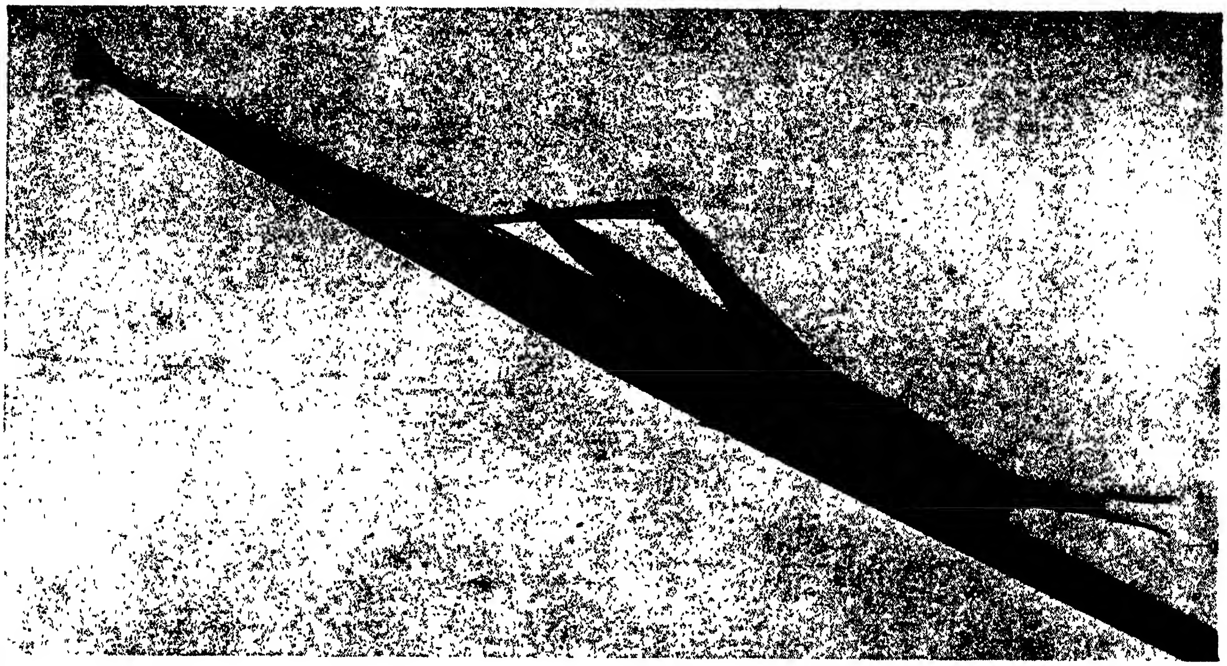
STICK INSECTS OF AUSTRALASIA, INDIA AND THE PACIFIC ISLANDS

All the stick insects do not live among the slenderest branches of the trees. Some live upon the bark round the main stems like the Australian specimen seen above (bottom left). When this creature is clinging to bark with its wings folded it is well-nigh invisible as an insect. Of the stick insects that live up to their name more than the first example, we have here (bottom right) a New Zealand prickly stick upon a dead branch, (top left) five Indian stick insects among twigs and (top right) a quartette of Pacific Island insects.

J. J. Wa

CREATURES THAT CUNNINGLY SEEM WHAT THEY ARE NOT

Some of the deceits practised by caterpillars are astonishing. Those of the lobster moth (bottom left), for instance, while restin make their full-fed bodies resemble the dry parts of the leaves on which they have been feeding. Larvae of the swallow-tailed moth bui up an amazing likeness to twigs. Two of the six seen in the bottom right-hand photograph have joined themselves together so as to be li' a forked twig. Above are (top left) a Brussels lace moth caterpillar resembling lichen and (right) comma butterflies like withered leave



Martin Duncan

VEGETABLE MIMICRY IN GRASSHOPPERS

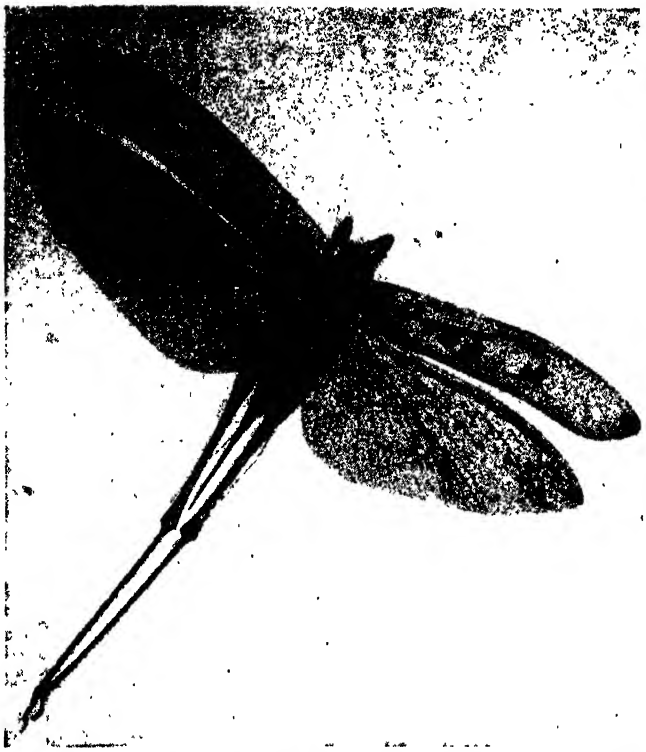
co which survives by virtue of its resemblance to a leaf while above is a short-horned grasshopper on a grass blade whose surface is copied by the insect's skin.

can certainly be no means by which the spinner can see the result of its labours. Nor can it know that presently it is to emerge from that cocoon as a moth—provided it can succeed in bamboozling the birds! In Chapter Three I described the extraordinary behaviour of the spider crab, which laboriously hooks pieces of seaweed on to its shell until it matches the weeds by which it is surrounded. Its strangely purposeful actions seem to demand that we should regard them as conscious efforts to deceive its enemies. This conclusion is difficult to adopt, and it becomes still more so when we recall that the caterpillar of the blotched emerald moth directly it emerges from the egg proceeds to cover itself with pieces of its food-plant, attaching to each a film of silk, and fastening them thereby to hooked spines with which the body is studded. On emerging from its hibernation it uses oak-leaves.

balls simulating the cocoons of parasites which feed upon the tissues of the helpless body within. Birds discovering such apparently infected cocoons pass them by without more ado, believing that nothing remains but empty husks. Thus, by simulating a parasitised cocoon they secure immunity from attack!

Here we seem to have evidence of foresight and cunning of a very high order. But let us be careful about jumping to conclusions. The cocoon, it is to be remembered, is spun by a caterpillar. It is a task performed without previous experience, and there

Now, it is hard to regard this apparently deliberate piece of camouflage as the outcome of conscious effort, for what can a newly emerged caterpillar know of its surroundings, and more especially of the ruthlessness of its enemies which must promptly be hoodwinked? Its near relation, the Essex emerald, behaves in exactly the same way. But curiously enough other




H. Bastin

EXTRAORDINARY DIFFERENCE OF APPEARANCE WHEN RESTING AND FLYING

The right-hand photograph is of a long-horned grasshopper clinging to a leaf, while the left-hand photograph shows the same insect in flight. The two illustrations are hardly recognizable as being both of the same insect, so extraordinary is the power of mimicry while the creature is resting. The grasshopper's very life depends upon this mimicry. While at rest upon a leaf it is much better that it should devote itself to rest secure in its wonderful pretence of being a part of its resting-place than use up energy upon constant watchfulness.

species of emerald moths practise no such subterfuge, but trust to their protective coloration and their habit of posing as pieces of twig.

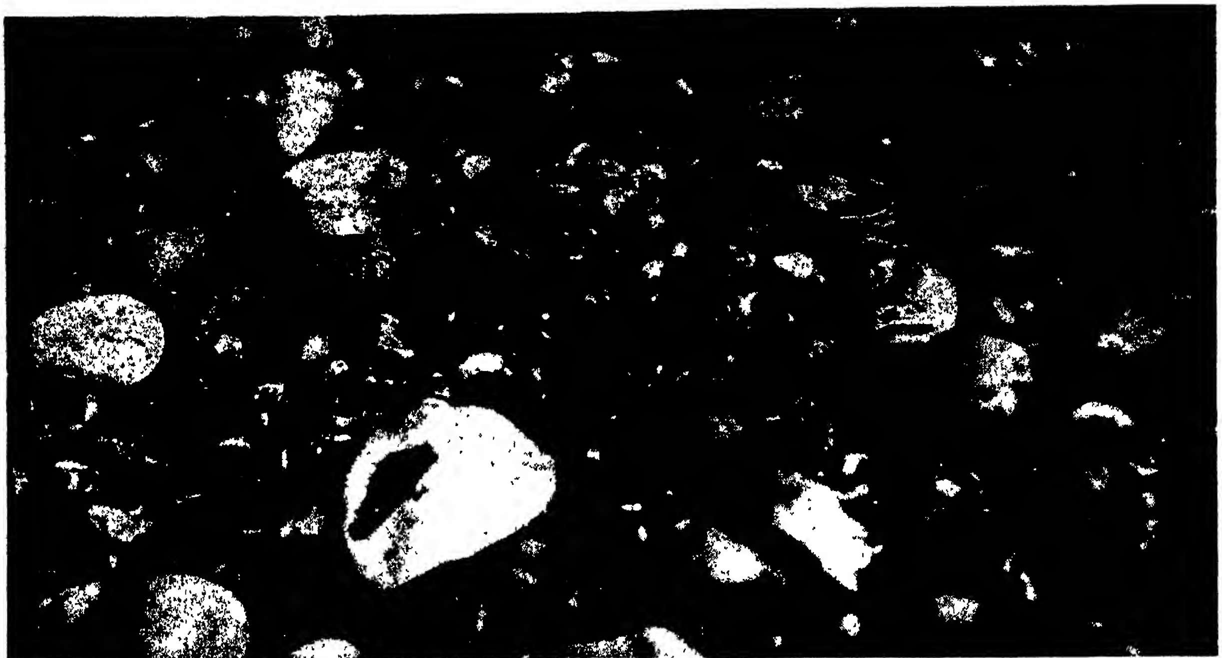
The larva of a small Hemirobiid insect—one of the Neuroptera, having no name in common speech—adopts a most extraordinary and gruesome device to protect itself. This consists in attaching the empty bodies of aphides which it has sucked dry to the long hairs of its body, forming with this material a sort of shell which looks merely like withered vegetable matter till it is closely examined.

Among the caddis-flies we find the larvae constructing most cunningly fashioned tubes for the protection of their soft bodies. Each species builds after a different method. One spins a shell, coiled like a snail shell, very like that of *Helicopsyche*, already described. Another builds tubes of coarse sand-grains, another of quadrangular stones. Short lengths of weed, bound together, and looking like little bundles of sticks attached one behind the other, or short pieces of coarse weed irregular in shape, are also used. Some use snail shells, and are quite indifferent as to whether the shell is empty or not! Finally, some use a whole leaf which has fallen from some bush overhanging the water. So that while the wearer is resting it looks just like a newly-fallen leaf lying at the bottom of the water!

It is curious to note that the sauba ant of Brazil, when it takes its walks abroad, holds a leaf, or piece of a leaf, in its jaws, but so as to turn the left edge upwards along its back thus very efficiently masking its body. Is this a device to escape detection—for ants have many enemies—or is it, as some suggest, merely an accidental benefit, the leaf being borne along for the purpose of furnishing material for the cultivation of a fungus within its nest. But the matter is complicated by the fact that a totally unrelated insect—a tree-hopper—has developed a laterally compressed body terminating above in a leaf-like edge, and green in colour, so that it looks like a leaf. Has the tree-hopper mimicked the sauba ant, or is the case the other way about?

There is a psychological aspect of this theme of coloration and camouflage which is very puzzling. The behaviour of some of these creatures seems to indicate reasoning powers of a very high order. But this is an assumption that will not stand the test of criticism. Reasoning must obviously have memory of experience behind it, on which to shape conclusions.

Now, a caterpillar newly emerged from the egg can have no knowledge of the existence of the enemies by which it is surrounded, still less of the need for disguising its body in order to escape being eaten! Yet we have seen that the caterpillar of the emerald moth, as soon as it leaves the egg, proceeds to hook pieces of lichen on to its back. We may say, if we



M. Duncan

BUTTERFLY'S CUNNING TRICK: SEMI-INVISIBLE CRABS

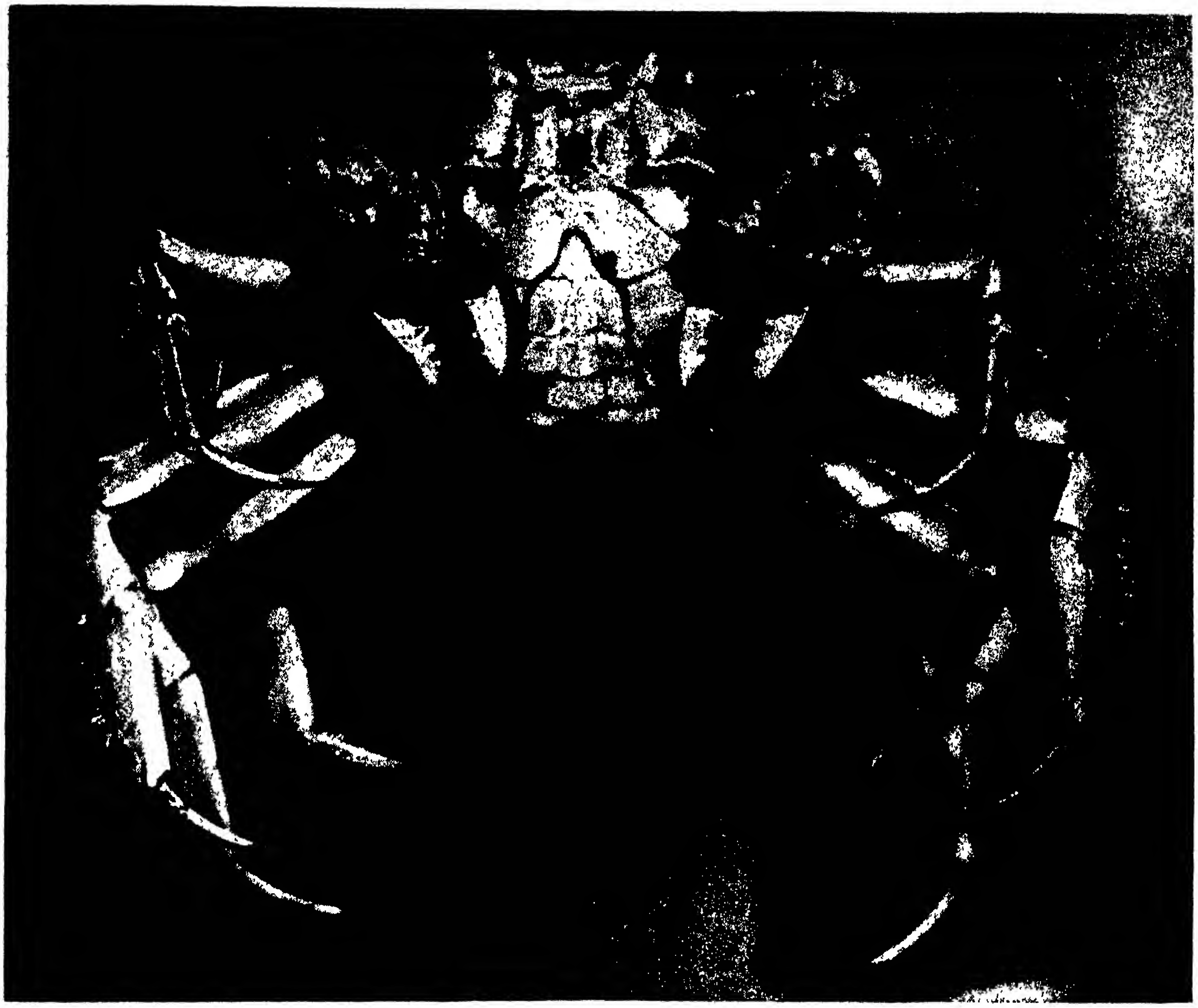
When a grayling butterfly settles it does so upon the ground, and lies over to one side so that one wing shall be uppermost, harmonising with the background and not casting any shadow that might attract dangerous attention. The upper photograph shows a portion of a seashore containing several almost invisible crabs imitating their surroundings.

like, that they act instinctively, and we are set wondering *how* such instincts could have arisen, and the wonder is heightened by the recollection that their "instructive" actions are associated with special structures—like hooked hairs—without which their instructive responses would be useless. But here are the facts translate them as we will. We have to recognize an evolution of behaviour delicately adjusted to keep pace with the evolution of structure. The two must keep a very exact response to the demands of the conditions of the environment. If the wolf is to wear sheep's clothing successfully he must act like a sheep.

Very helpful in this connexion is the less complicated cases furnished by the sargasso-fish—one of the angler-fishes. It lives in the famous sargasso weed of the Gulf Stream, and in its coloration marvellously matches its surroundings, even developing small white spots to resemble the similar spots on the surrounding weeds due to small organisms known as bryozoa. Further than this, its pectoral, or breast fins have become transformed into claspers wherewith to clasp the weed, and so maintain an absolutely motionless poise without effort. This is essential; for it is invisible to its prospective prey only so long as it does not move.

ANOTHER dweller among seaweed is a large Australian species of sea-horse which has developed enormously long filaments of skin all over its body, thereby causing it to blend with the long leaves of the weed amid which it hides. But in this case the disguise is not so much to deceive its prey as to deceive its enemies. Here, again, unless the instinct to remain motionless is fully developed, the likeness of the body to its surroundings is unavailing. Structure and behaviour must always harmonise; they must be reciprocal.

And now let us pass to some other no less remarkable cases where peculiarities of structure and unusual behaviour have to keep pace with one another. These are furnished by caterpillars. Let us take the caterpillar of the puss-moth. Already coloured



Neville Kingston

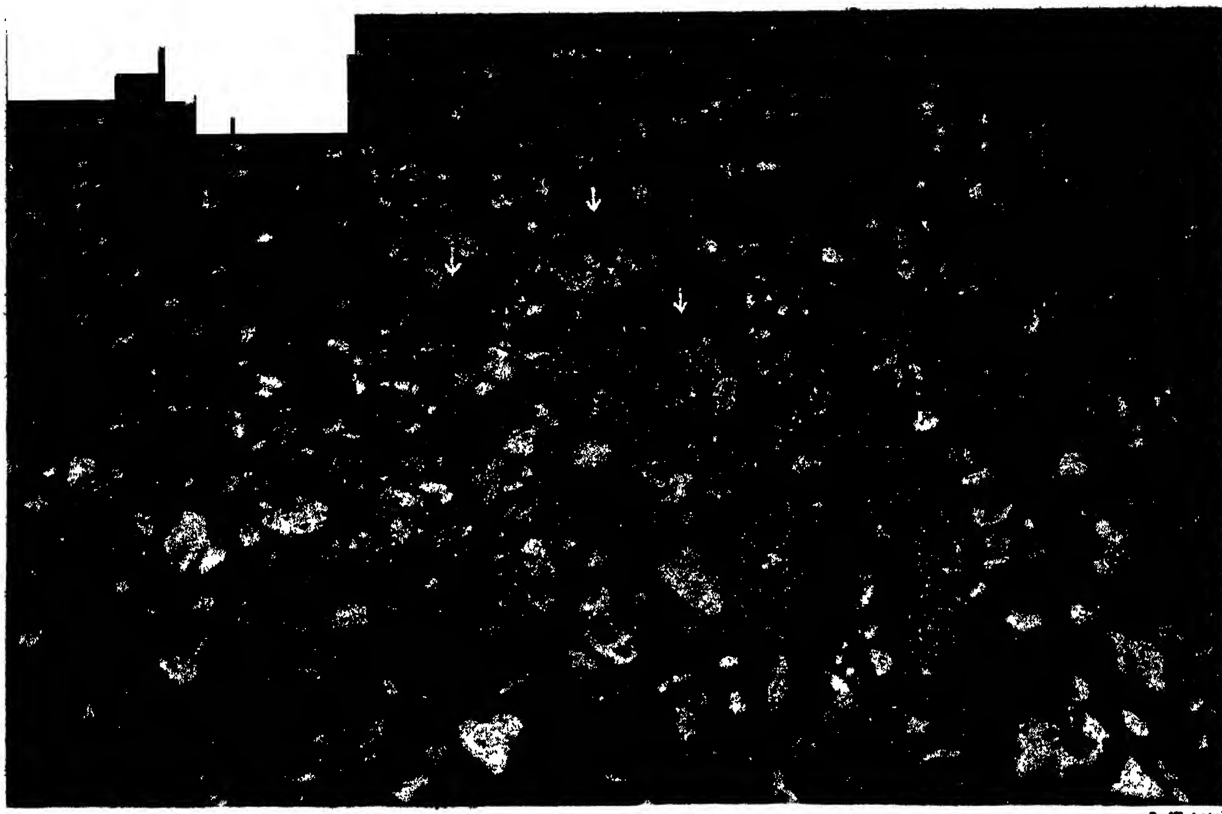
so as to harmonise with the leaf on which it is resting it will, when alarmed, face the enemy, and retract the head so that it is surrounded, as in a frame, by the bulging walls of the body segment immediately behind. This brings into prominence a vivid red ring and two intensely black spots looking like eyes so that the bewildered enemy is suddenly confronted by a very weird and forbidding-looking face.

But this is not all. At the same time it turns the end of the body upwards over the back and thrusts out a pair of long, red, waving filaments! These filaments and their sheaths are worth a little attention, for they have come into being by transforming the last pair of hind-legs. Here, again, this special and very remarkable transformation of the hind-legs for a special purpose would be useless unless it was

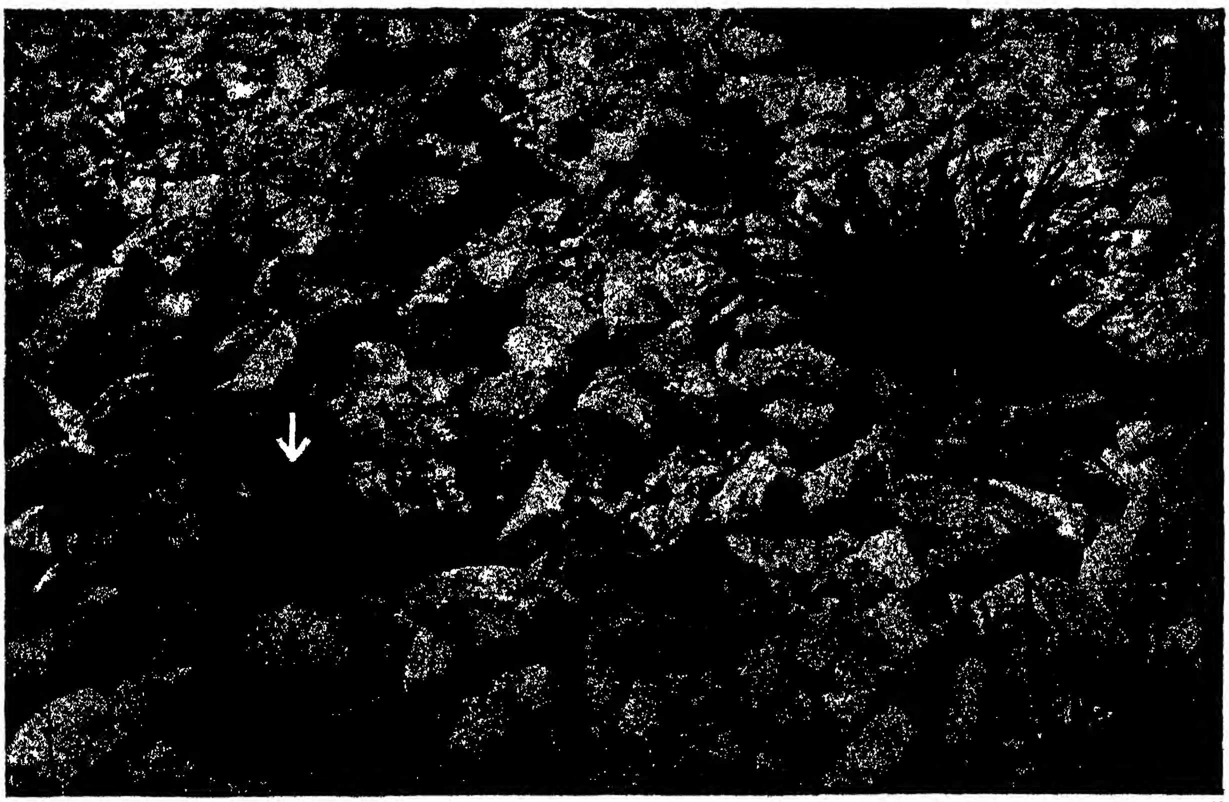
E. Step

CRABS UTILISING SPONGE AND SEAWEED

Below is a crab that has decided to resemble the bottom of the sea more closely by attaching a growth of sponge to its back. Of course, when the crab moults it will have to find something else to disguise its new shell—some seaweed, for instance, as the crab in the top photograph is doing. Its claws are covered.



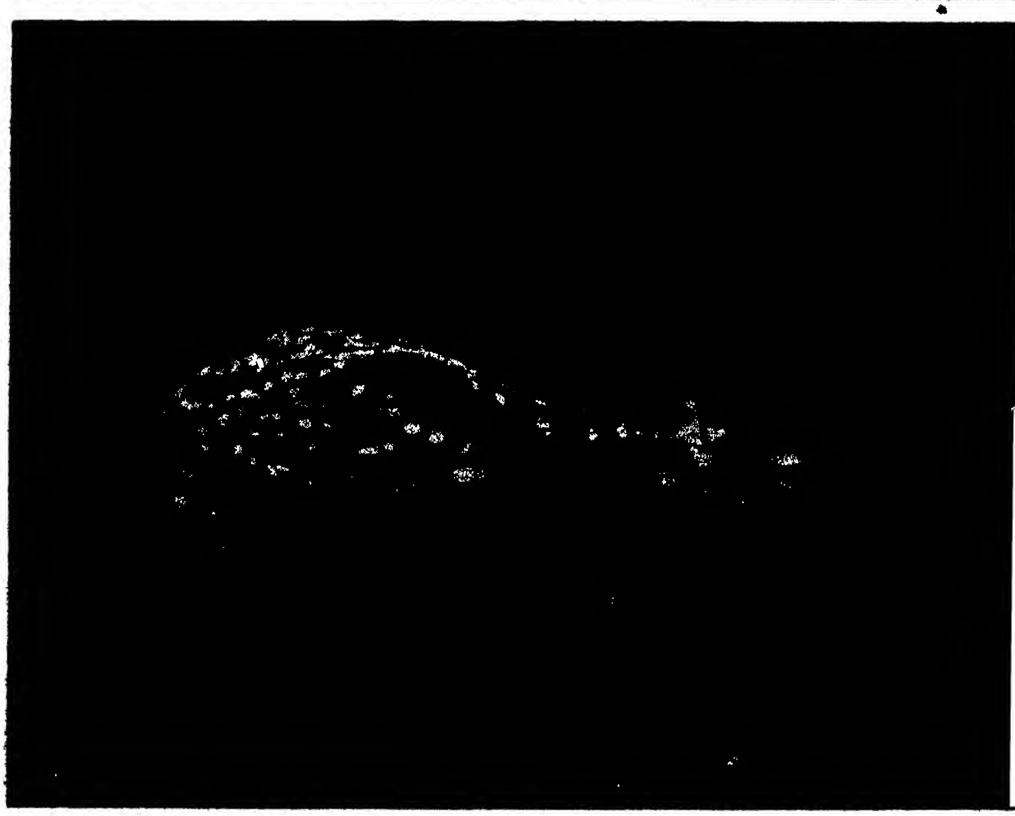
F. Webster



STONE CURLEW AND LESSER TERNS CLOSELY IMITATIVE OF THEIR SURROUNDINGS

As its name suggests the stone curlew has a partiality for pebbles, and particularly is this so when it wishes to lay and hatch its eggs. The eggs themselves and the young chicks both imitate so well the stones among which they lie that it is a hard matter to detect the presence of either. The lower photograph shows a young stone curlew in typical surroundings. Above are three young lesser terns, almost invisible among the stones and loose sand. If these little creatures start to run, the effect is as though the stones were moving.

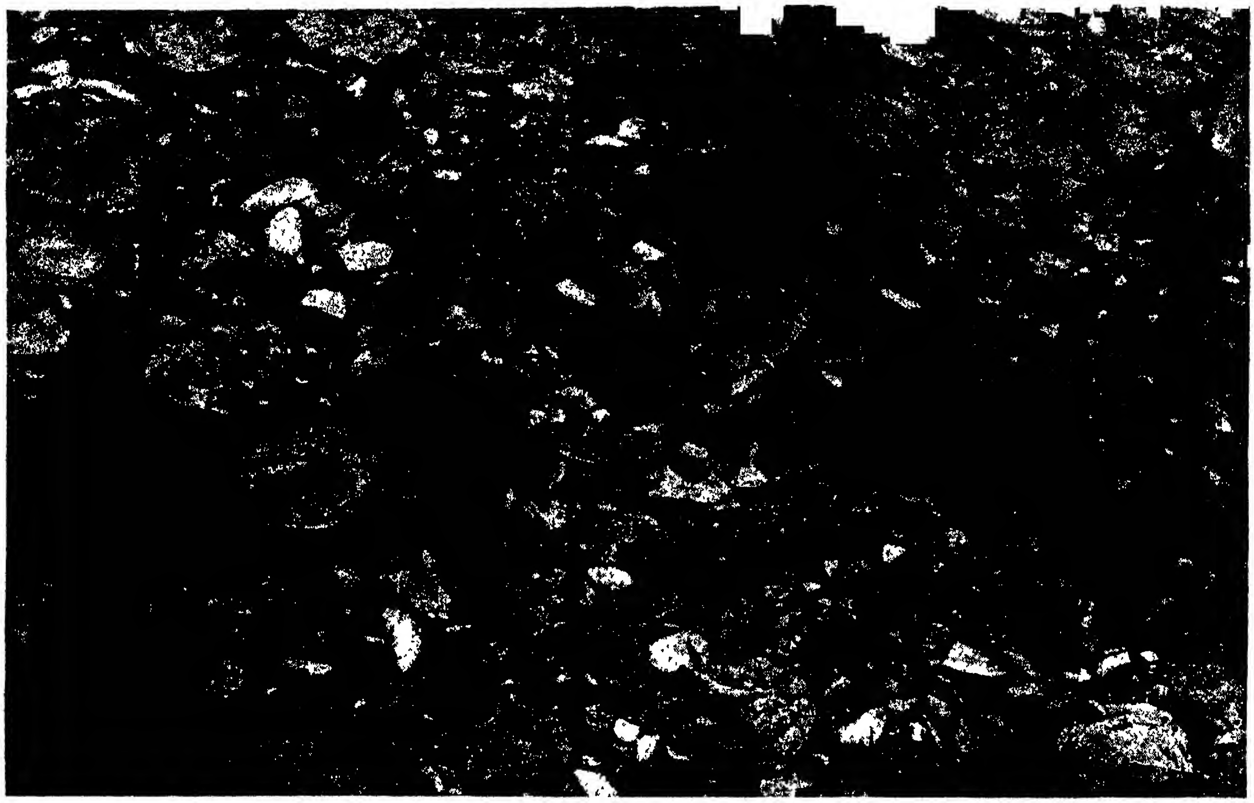
A. H. Willford

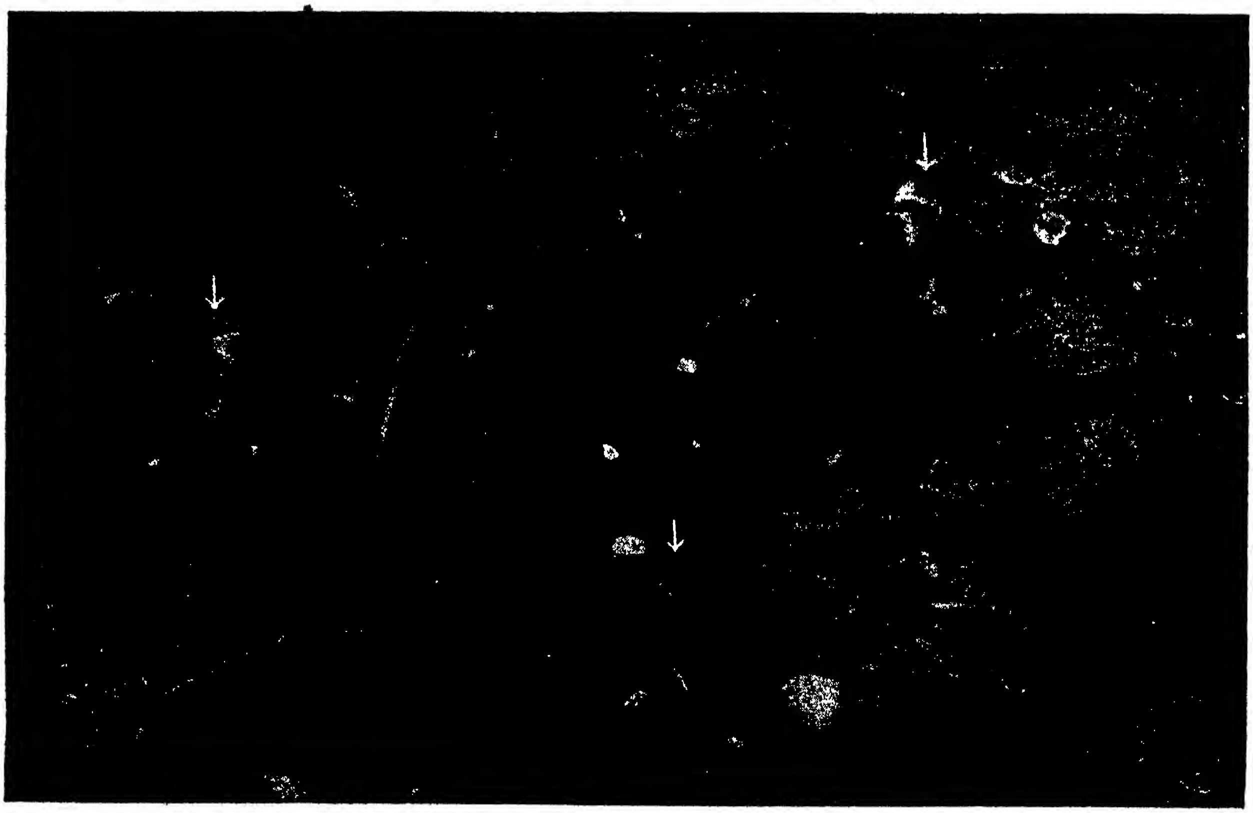


A. B. Beattie

HOW A FAWN AND A LEVERET FADE INTO THE LANDSCAPE

When photographed this fawn (bottom) was only five days old, and at such an age protective colouring must come to the aid of weakness if the young stag's chances of surviving the dangers of wild life are to be anything but small. The upper photograph is of a month-old leveret crouching in the grass. Its fur is wonderfully matched to the background, although, of course, there is not a particle of green in the whole skin. Living in the open, the hare's ability for being invisible must of necessity be tremendous.





CHICKS AND EGGS OF PLOVER PRETENDING INVISIBILITY

Invisibility is made a fine art by young plovers. The lower photograph shows three of these birds squatting in the sand against which they look at a distance of a few yards like indistinguishable portions of the ground. Above is a Kentish plover's nest that is a depression in the shingle. Among the litter of stones and broken shells the three eggs are concealed as well by imitative marking as though they were buried. The Kentish plover gets its name from the fact that it was first noted as a separate species on the Kent coast.

A. H Willford

P Webster

NESTING BIRDS ELUDING OBSERVATION: WOODCOCK AND RINGED PLOVER

A single watching eye is the most salient feature of this sitting woodcock which stretches itself straight out upon its nest, remains motionless and lets the mottling of its feathers settle the question of invisibility. Above we see a ringed plover in the act of pushing herself on to her eggs, which are laid in the open among the sands of some lonely shore. The eggs, of course, harmonise with their surroundings, and when the mother covers them they are still as well protected from observation.

accompanied at the crucial moment by the appropriate behaviour. No less remarkable is the caterpillar of the lobster moth. Coloured to resemble a dead leaf, its body is further transformed by angular prominences along the back, and exceptionally long fore-legs, while the hinder part of the body can be made to assume a curiously plump appearance when it takes up its terrifying attitude. This it does when alarmed. On such occasions the fore-part of the body is raised up and the long legs spread out, and set quivering as though in its frenzy it were striving to seize the intruder.

Finally, let me cite the singular case of a grasshopper which simulates a hissing snake. Professor Gregory tells us that during his exploration of East Africa he was strolling one evening out of the camp when he was startled by a hissing noise like that of a snake from a clump of grass. Springing back he pelted the grass with sand. But as no snake emerged he approached and peered into the clump, where he could just see a small green head which, whenever the hissing noise was made spread out like the head of a cobra. He tried to kill the creature by blows with his stick behind the head—and one of these knocked it over. Stooping to pick up the victim he found not a snake, but a grasshopper!

M. Duncan

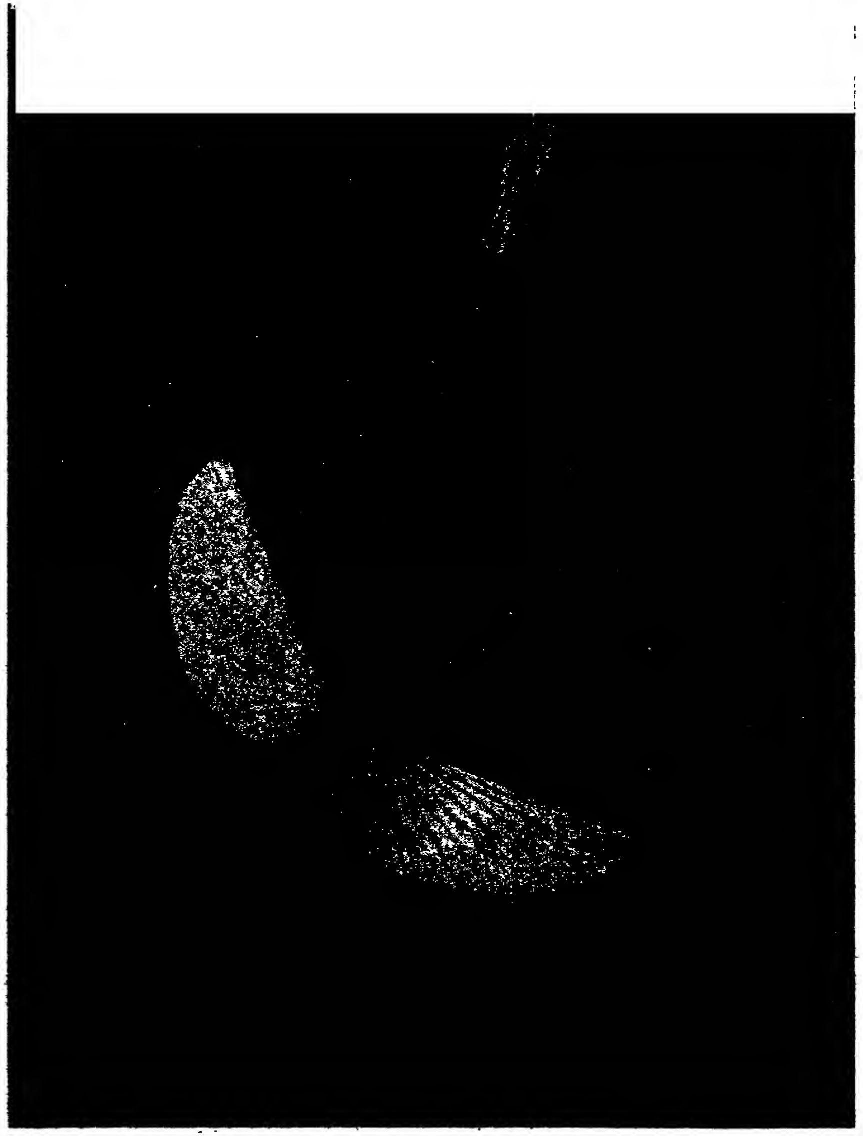
MONK FISH SEEN BY THE CINEMATOGRAPH CAMERA: SPIDER SHAMMING DEATH

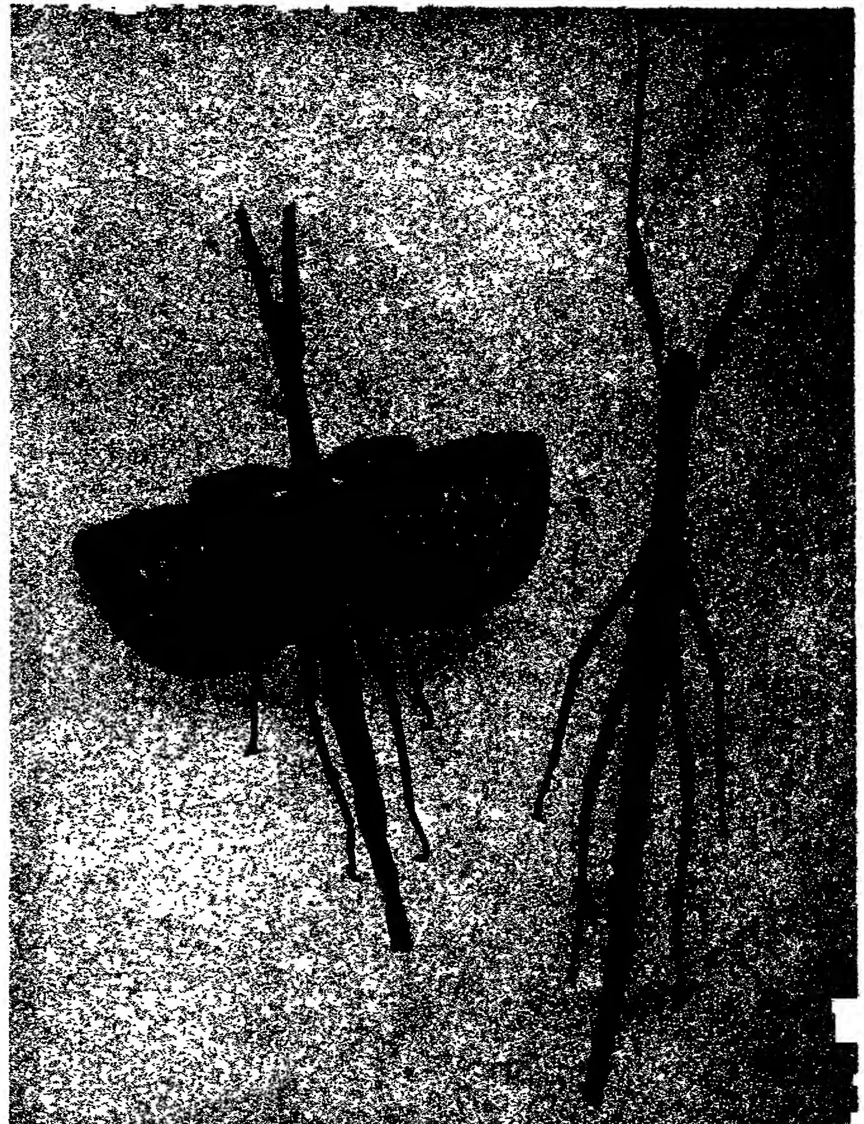
Fish that swim close to the bottom, such as the skates, plaice and halibuts, or the monk fish, of which last we have an example here, are light below and parti-coloured above, so that they harmonise with their surroundings. In this case the fish shows up much more than usual because, for photographic purposes, the light had to be much stronger and the water clearer than in natural conditions. Above is another case of make-believe—a spider (top photograph) journeying across a doorstep and (lower photograph) shamming death on being frightened

J. J. Ward

WONDERFUL EXAMPLES OF MAKE-BELIEVE AMONG THE INSECTS

Like pieces of a broken branch when the wings are closed, the buff-tip moth (bottom left) has adopted a remarkable way of escaping the notice of enemies. The rose-leaf moth (bottom right) is still more ingenious, for when it folds its wings on a rose-leaf it resembles the droppings of a bird. Above are some cocoons of the fig-wort weevil (top left), the larvae of which are exactly like the seed capsules of the plant on which they live. A number of larvae of flata (top right) on a branch look rather like a piece of the plant "honesty."





H. Bastin

INSECTS EXTRAORDINARY: WEIRD-SHAPED CREATURES THAT LIVE AMONG LEAVES AND TWIGS

Members of the family of the Phasmidae, comprising the stick and leaf insects, are among the most queerly-shaped creatures that the world knows. The specimen on the left, for instance, resembles a grass-stem when its wings are closed and is said to behave like a ballet dancer when they are open. The right-hand photograph shows another of these extraordinary-looking insects which so closely resemble the pieces of vegetation among which they live. These insects can, to some extent, replace lost or damaged limbs, though strangely enough, a lost leg is sometimes compensated for by a new antenna or vice versa. In some members of the family, also, the male is very rarely found and many generations appear which seem to be entirely composed of females.

Chapter LXXII

Insects of Strange Form and Habits

By F. Martin Duncan

Librarian to the Zoological Society of London

Among the many curious inhabitants of the insect world—and their name is legion—the praying insects, or soothsayers (*Mantidae*) have long attracted special attention not only from their strange appearance but from the almost world-wide reputation for piety and wisdom that they, quite undeservedly, enjoyed in olden times.

These strange creatures are found only in warm countries; they are mostly of large size, as insects go, and are usually coloured to blend harmoniously with their surroundings—being green, brown, or parti-coloured to match the foliage, grasses or flowering plants among which they habitually dwell. The whole "make-up" of the Mantis family is decidedly original. The fore-part of the body is unusually drawn out and has a curious resemblance to a long, giraffe-like neck, on the top of which is perched a queer-shaped head (usually triangular, but sometimes round or long) complete with two great, bulging eyes which the insect twists and turns about in all directions with a most absurd effect.

But the most singular part of a mantis's anatomy is the remarkable structure of its fore-legs. They are abnormally long and strong and the third joint, which we may call the thigh, is broad and flat and has a row of sharp, curving spines along the outer edge. The fourth joint, or shank, is also armed with spines and can be folded back upon the thigh like the blade of a clasp knife. The two rows of spines then interlock and form a veritable vice.

When resting in its characteristic attitude the mantis stands upon its four ordinary legs, raises the long, neck-like portion of its body, casts its eyes heavenwards, and uplifts its fore-limbs as if in supplication; and thus, motionless, the strange creature will remain for hours together. This devotional posture so impressed superstitious people in bygone days that the insect was looked upon with awe and wonder and credited with divers virtues and miraculous powers. The ancient Greeks believed it to be engaged in meditation on futurity and so bestowed the name "mantis"—that is, diviner—upon it. Pious folk declared that it was wrapt in prayer and to this day it is known in different parts of Southern Europe by such names as "prie-dieu," "prega-diou," and "fouva-dios," while in the East the Turks and Arabs assert that the mantis always "prays" with its face turned towards Mecca.

Many quaint legends were invented about this gifted insect, and a very old naturalist gravely informs us: "So divine a creature is this esteemed, that if a childe aske the way to such a place, she will stretch out one of her feet and show him the right way, and seldom or never misse. Her tail is two-forked, armed with two bristly prickles; and as she resembleth those Diviners in the elevation of her hands, so also in likeness of motion; for they do not sport themselves as others do, nor leap, nor play, but, walking softly, she retains her modesty, and showes forth a kind of mature gravity."

But these hypocritical insects no longer impose upon us. Their true character now stands revealed, and they are known in reality to be the most savage, bloodthirsty little wretches possible—regular ogres of the insect world. Their saintly demeanour is merely a pose and "for ways that are dark and for tricks that are vain" a praying mantis could give points to Bret Harte's "Heathen Chinee," for when seemingly wrapped in profound meditation it is actually engaged in keeping a keen look out for something to kill and devour. The moment an unsuspecting insect alights near by, the mantis with slow and stealthy steps moves towards it; a long limb shoots out, and "click," the unhappy creature is caught and crushed in the diabolical leg-trap. After tearing its prey piecemeal with its strong jaws the mantis once again uplifts its paws, as if it were saying grace after meat, and patiently and piously awaits another victim.

But this is not all. Even when hunger is appeased the insatiable insect will continue to slay every small living thing that comes within its reach. It is quarrelsome, too, and whenever it happens to meet another of its own kind it at once begins to fight. The two attack each other furiously, lashing out viciously with their sabre-like fore-legs until one of the antagonists overcomes its opponent, not infrequently by slashing off its head. When the battle is over the victor forthwith proceeds to make a meal of the vanquished and if, as is often the case, a male and female have been fighting it is usually the male, who is the smaller of the two, that furnishes the feast.

Little in the way of food comes amiss to the mantis; it preys upon flies, bees, caterpillars, grasshoppers, and all soft-bodied insects; tough-skinned creatures such as beetles are killed but usually soon discarded, while certain large South American species are said to capture and devour such prey as small frogs, lizards, and even birds.

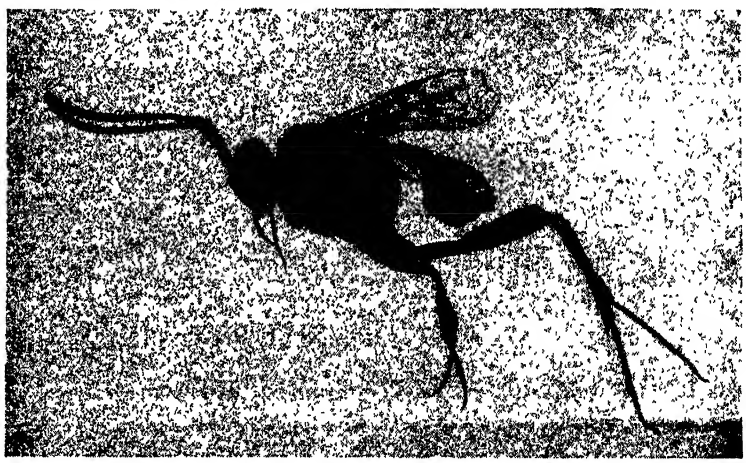
There are probably quite six hundred different species of mantis distributed over the warmer parts of the world. The insects are from one to six inches in length. Many have brightly-coloured hind-wings, resplendent in red, mauve, pink and blue, but when the insects are at rest they are concealed beneath the fore-wings, which are thicker in texture and usually leaf-like. Some species, in addition, have leaf-like expansions on their legs, while others are so flower-like that even butterflies are deceived by them.


F. W. Bond

is hidden from view between them. In this attitude it will remain, perfectly motionless, all day; but when the light fades the "walking-stick" comes to life and begins to move slowly and laboriously over the grasses, its long body swaying from side to side on its inadequate legs, which seem too feeble to support its weight. Having, probably, fasted all day it is extremely hungry and it spends its short period of activity in feeding vigorously on the surrounding vegetation..

Some of these insects, (frequenting damp forests in tropical America, and the Malay isles) to make their disguise more convincing, have the most extraordinary excrescences dotted all over them, making them look like moss-covered twigs; others have leaf-like processes sprouting from their bodies and legs; others again are covered with prickly spines and look exactly like the thorny stems of the bushes on which they make it their business to live.

Many forms are wingless, but others possess delicate and beautifully-coloured wings which, however, are not conspicuous when the insects rest in their normal quiescent state. They fold up like a fan, lying flat and close against the sides of the insects without destroying the lineal outline of their stick-like bodies. Some species are quite small, barely an inch long, but others grow to a length of eight or ten inches, though even then they are hardly thicker than knitting needles, while a gigantic Australian walking-stick (*Acrophylla titan*) is a foot long and as thick as a man's finger. Being strictly vegetable feeders the larger kinds sometimes seriously damage forest trees. A curious fact in connexion with these


H. Bastin

ECCENTRICITIES OF SHAPE

Below is an amazingly shaped wasp-like parasite with an extraordinarily small hind body and an unusually placed waist attachment. Above is one of the more bizarre of the rapacious insects belonging to the mantis family. Not only is its attitude grotesque, but its bodily form also.

The variety of forms assumed by these deceptive insects is amazing. Not only are leaves, lichens and flowers simulated by different members of the mantis family, but certain species mimic other types of insects. One mantis so successfully counterfeits a harmless stick-insect that its disguise would be perfect if its raptorial legs did not betray its real nature.

The stick-insects (*Phasmidae*) are totally different in character from the rapacious *Mantidae*, although in appearance they are, perhaps, even more extraordinary. Their popular names—stick-insects, or walking-sticks—describe them fairly well; for although different species show a remarkable variety of form and colour the majority have a distinct resemblance to sticks, twigs or plant stems. They are a feeble, timid folk, whose chief anxiety in life, apparently, is to escape observation. In this they are eminently successful, as in their form, colour, and the attitudes they assume, they conform to the natural objects among which they dwell in so marvellous a degree that only a keen and practised eye is at all able to detect them.

ONE species, for example, that lives among long grasses is almost a replica of a grass-stalk. Its long, cylindrical body is identical in thickness and its colour is green when the grass is fresh and turns correspondingly yellow or brown as it fades. Its favourite habit is to rest with its feet clinging to a tall grass-stalk, its almost thread-like legs—that is to say the two hinder pairs—pressed closely against its sides, while the fore-legs, which are very long, are stretched straight out in front in such a way that the insect's head, with its eyes and antennae,

insects is that they possess the power of reproducing lost limbs. The new limbs, however, are never quite as large as the original ones, and what is even more curious is that they do not always grow true to type. For instance, an absent-minded stick-insect will occasionally replace a lost antenna with a new leg, or vice versa.

Equally anxious to pass unnoticed amidst the teeming life of the tropical forests are the walking-leaf insects. They are nearly related to the stick-insects, but have devloped the family trait of dissimulation on different lines. Instead of being long and thin they are broad and flat, and in shape and colour approximate so closely to the foliage of the trees that form their natural habitat that they are practically invisible unless they destroy the illusion by moving.

H. Bastin

INSECTS EQUIPPED WITH BEAKS

From South America, home of so many strange forms of life, comes an insect whose official name is Rhinastus. Not only has it a long thick beak, but also strange processes on the ends of its legs. Above is a nut weevil, with its thin, curved beak, nearly as long as its body.

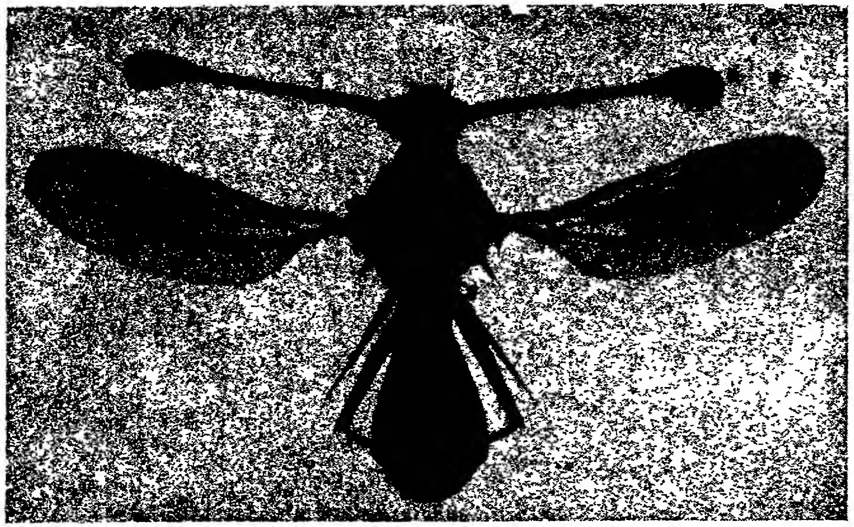
The fore-wings of a walking-leaf are typically leaf-like and lie flat over the depressed body of the insect, while the legs appear as small leaflets, or bits of leaves, projecting from the sides. To heighten the effect the head, together with the first segment of the body, represents a short swollen leaf-stalk. So perfect is the impersonation that in the East Indies, where the creatures abound, the natives firmly believe that they actually are leaves which have been miraculously transformed into insects.

THAT the leaf-like nature of these peculiar creatures is more than skin deep is suggested by the fact that, although strictly vegetarian in their diet, if two walking-leaves are shut up together without their natural food, they will satisfy their hunger by nibbling little pieces out of each other's wings and legs. It is worthy of notice, too, that the eggs of both stick and leaf-insects are so extraordinarily like seeds in appearance that even botanists have, at first sight, been entirely deceived as to their true nature.

Another insect that is worthy of notice on account of its strange mode of life, and the cunning way in which it overcomes its natural deficiencies, is the ant-lion, or rather, we should say, the larva of the ant-lion, for the perfect insect is in no way remarkable in its habits. On emerging from the egg the young ant-lion is a veritable "ugly duckling," in every way the antithesis of the graceful, gauzy-winged insect it will eventually become. It has a squat, bulky body, rather like a compressed egg in shape, beset on each side with numerous tufts of black hairs and surmounted by a large, flat head armed with a formidable pair of sickle-shaped jaws. Its legs are too feeble adequately to support its heavy bloated body, and as the hind pair are permanently fixed against its sides the insect is unable to move in a forward direction, but is condemned throughout the whole of its larval life to shuffle slowly backwards. Now, the ant-lion is a carnivorous creature, and if it were obliged to rely solely upon its activities it would fare very badly—for a retrograde mode of progress is not well suited to the capture of lively insects. So the wily creature resorts to strategy in order to procure a sufficiency of animal food.

Choosing a site where the soil is dry and sandy the ant-lion walks slowly backwards, describing a circle on the ground. As it goes it shovels the loose sand on to its flat head and with a sudden jerk flings it outside the circle. Round and round the odd little creature plods, working in a spiral until it has succeeded in excavating a funnel-shaped pit two inches deep and about three in diameter. Then, its task accomplished, it proceeds to bury itself in the sand at the bottom of the pit, leaving only its jaws and the front part of its head exposed to view, and patiently awaits the reward of its labours.

It seldom has long to wait. The chosen locality is always swarming with busy ants, fussy little beetles and such "small deer," and many an inquisitive insect pauses on its journeyings to and fro to peer down



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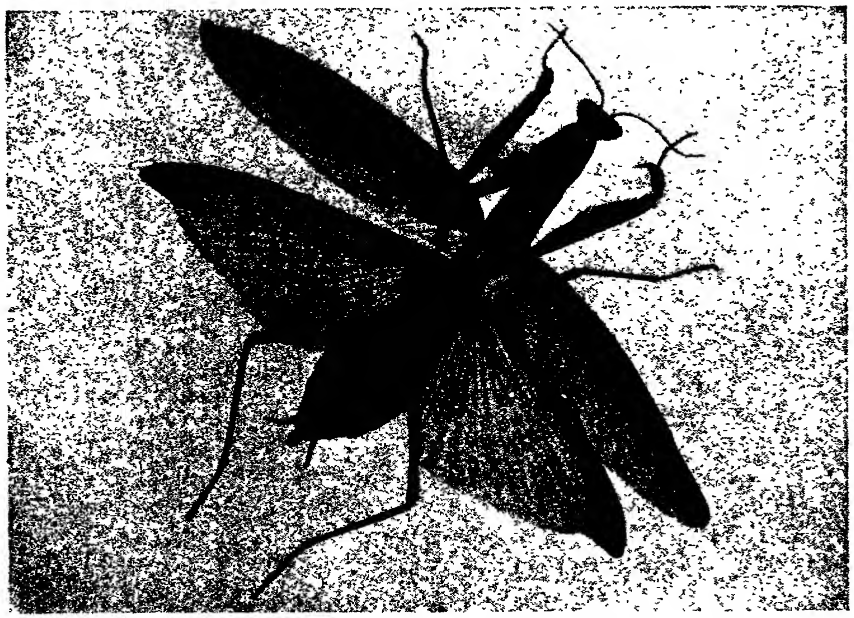
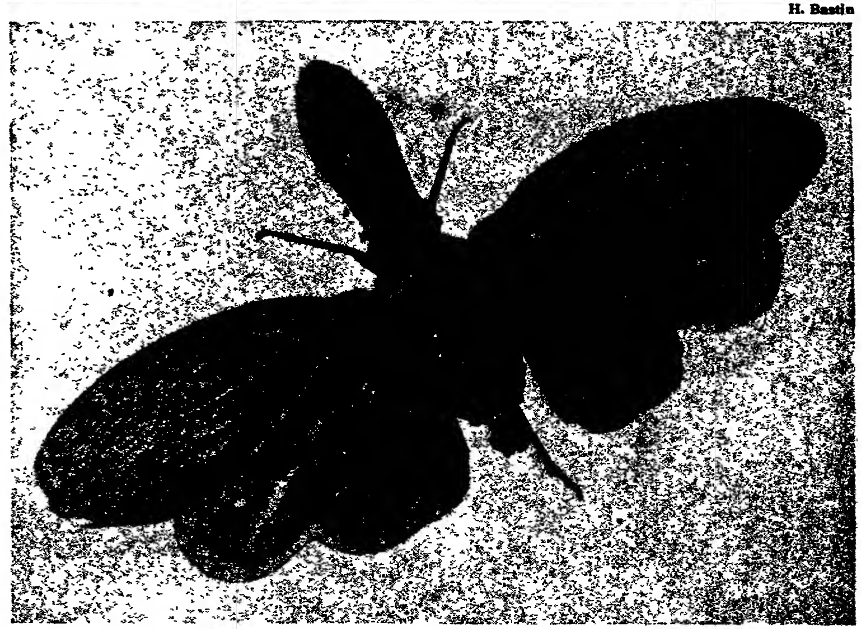
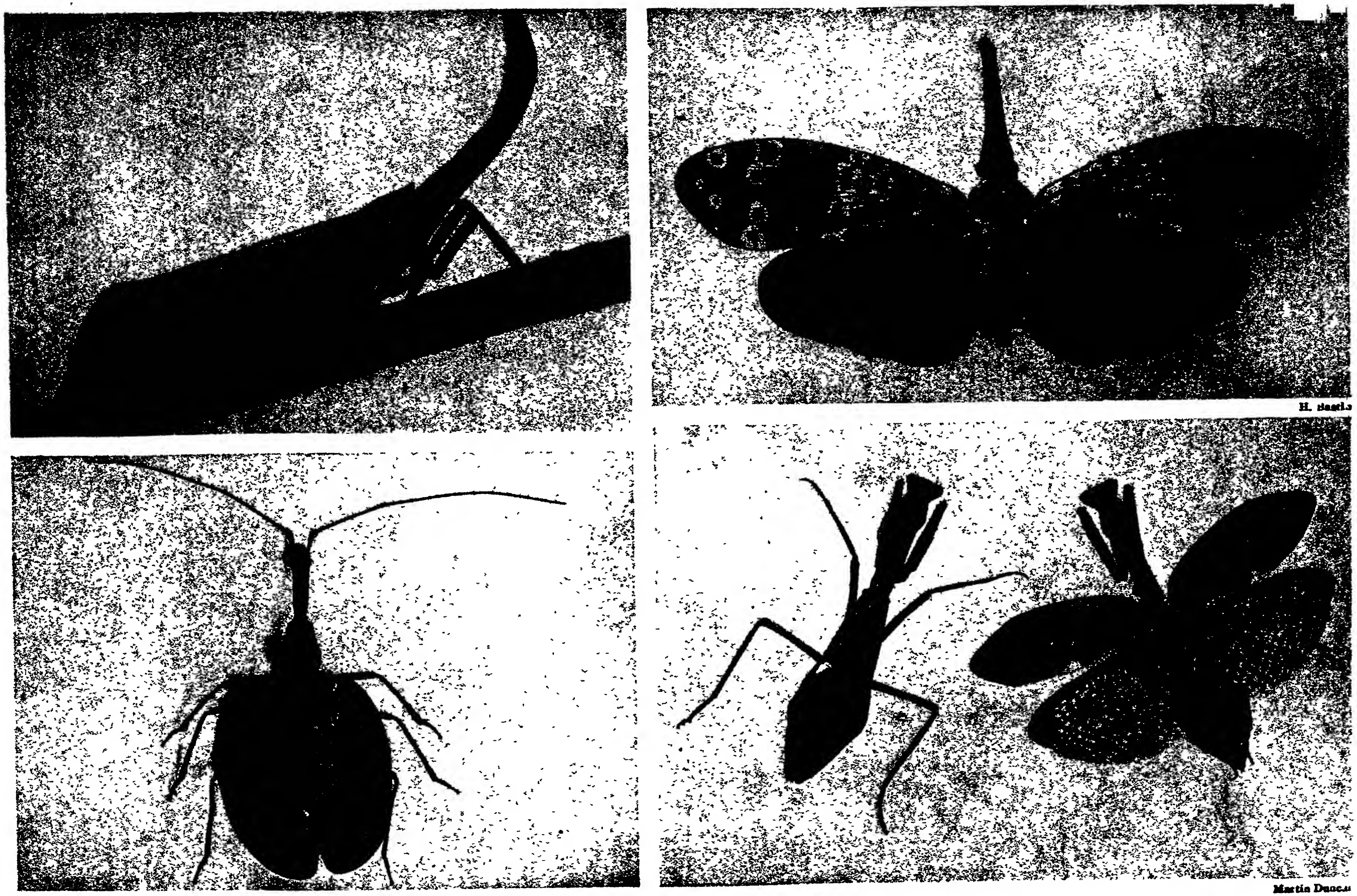




Martin Duncan

PRAYING MANTIS, GIANT LANTERN FLY AND A STALK-EYED FLY

The word "mantis" is a Greek one and means soothsayer, for this insect of strange form was thought of old to be endowed with strange powers. The bottom left and top right-hand photographs show two of these creatures. The mantis was once believed to be a benevolent guider of lost children, pointing the road for them with outstretched leg should a child ask the way. In reality, the mantis is the fiercest insect in existence, so far as other insects are concerned, and kills not only to feed but for the mere lust of killing. The bottom right-hand photograph shows us one of the giant lantern flies of Brazil, while in the top left-hand photograph is a fly from south-eastern Africa, which has eyes on stalks, and the stalks nearly as long as the outspread wings.



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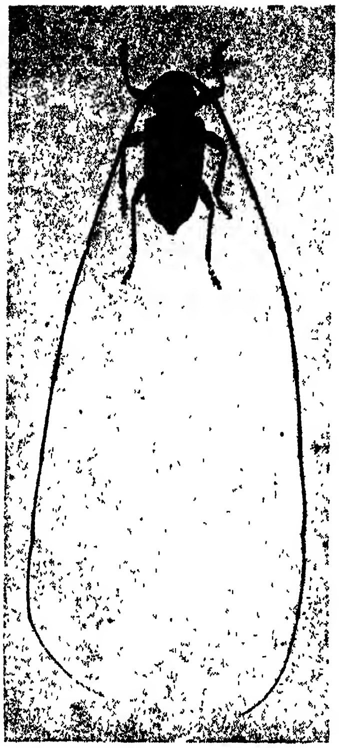
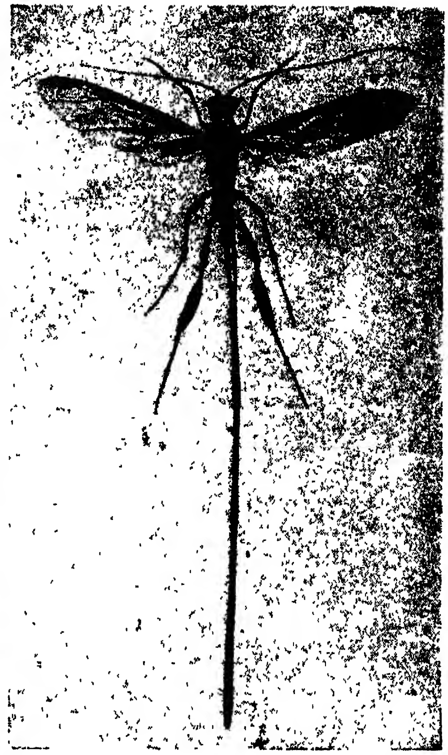
Martin Duncan

FOUR REMARKABLY-SHAPED INSECTS FROM THE TROPICAL FORESTS

Among many remarkable beetles is the "fiddler," or violin beetle (bottom left) found in China and Java. Its body, shaped something like the outline of the back of a violin, is so flat tha the beetle can squeeze itself into very narrow crevices, and this it must do since it makes its home under the bark of fallen trees. Another extraordinary insect is the lantern-fly (top photographs), which received its name because, in some way, the idea arose that its large, ungainly proboscis was illuminated at night. This idea has been proved erroneous, but the purpose of such a snout remains a mystery. This specimen comes from Tongking and is seen with its wings open and closed. Below (bottom right) is a mantis, also with wings open and closed





H. Bastin

EXAGGERATED FORMS OF INSECT BODIES

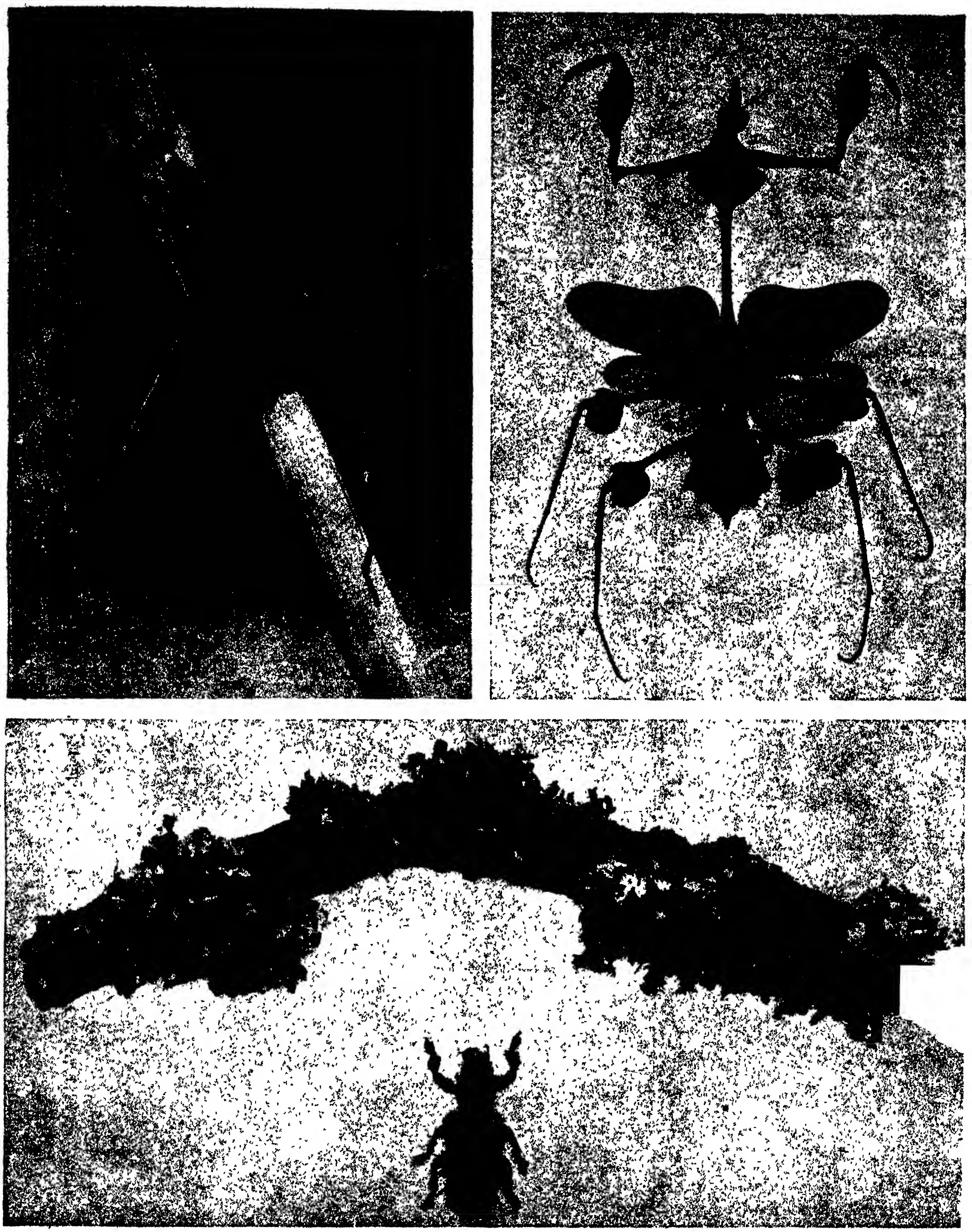
Here is a strange species of British origin, the timberman beetle (left), which is mostly found in Scotland, where it lives in fir trees. The remarkable antennae are very considerably longer than the insect's body. The centre photograph shows us the male of the long-headed weevil. The strange prolongation of the fore part of the male is well seen here. The right-hand photograph is of a weird parasitic, wasp-like insect with a very long and greatly attenuated hind body.

into the pit. This is its undoing; the loose sand on the bank gives way under its feet and the luckless insect begins to slip down the sloping sides of the trap. Its struggles only make matters worse; it rolls helpless down the treacherous incline into the jaws of the ant-lion, who hastens the denouement by frantically scooping up the sand with its head and flinging it in showers over the poor thing. Whether this manoeuvre is intentional or merely the outcome of the ant-lion's excitement at seeing its dinner arriving it is impossible to say. In any case, the effect is the same, and the savage little creature after sucking the juices of its victim again brings its useful head into play, and tosses the empty skin outside the boundary of the pit.

When full grown the ant-lion's appetite fails, and it constructs a globular cocoon of grains of sand bound together with fine silken threads produced from a slender spinneret at the end of its body. Within this cocoon the insect rests until its metamorphosis is complete, when it emerges transformed into a slim-bodied, gauzy-winged creature not unlike a dragonfly.

Butterflies and moths, on the whole, show less originality in form and behaviour than other types of insects. Many of the lepidoptera, of course, are protectively coloured, and of these the well-known Indian leaf-butterfly (*Kallima inactus*) that mimics a faded leaf in the dry, tropical forests, is a striking example, but any departure from the recognized customs of their kind is usually confined to their caterpillars. To feed and grow is the sole purpose of their larval existence, and to escape the keen eyes of insectivorous creatures their chief anxiety. This the majority achieve by protective coloration, though certain species—such as the larvae of the puss moth and lobster moth—bravely defy their enemies by assuming aggressive attitudes to scare them off. The caterpillars of the Psyche moths, however, carry the art of self-protection a step further by fashioning for themselves the most ingenious homes or garments wherein they may hide their plump and tempting little bodies completely.

The Psyche moths (*Psychidse*) have a wide distribution, and are known in various parts of the world as "basket worms," "case-moths," "house-builders" or "sack-bearers." Each species in building its habitation uses the material and follows the traditional design peculiar to its own particular branch of the family. The caterpillar of one little Psyche moth may often be seen wandering over heaths and grasses attired in a voluminous garment strangely reminiscent of an old-fashioned flounced skirt. This odd contrivance is made up of several rows of tiny bits of leaves arranged one above the other and finished off round the top with a row or two of fine fragments from sprigs of broom or heather. The whole affair, which is about an inch long, is held



H Bastin

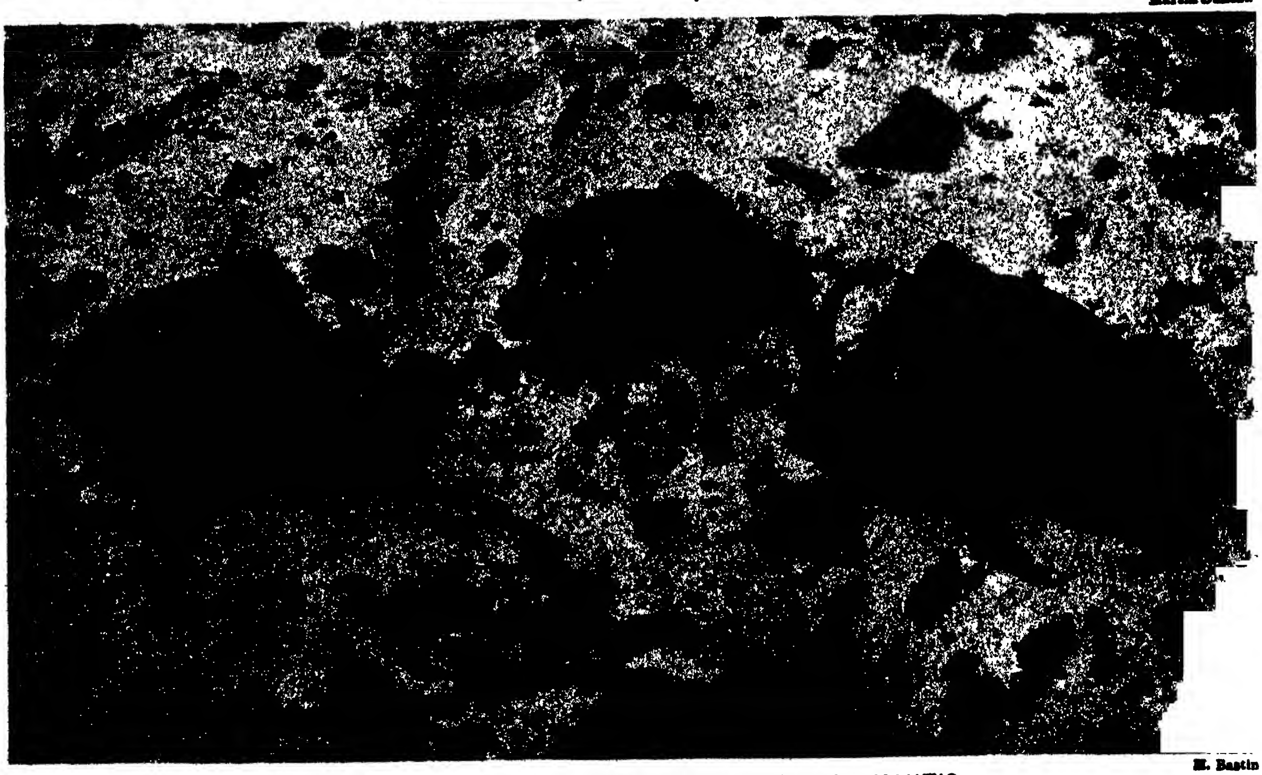
CAMOUFLAGED INSECT FORMS OF THREE CONTINENTS

n the great island of Madagascar there lives a kind of beetle whose name is Lithnius, and its body is formed to represent a growth of lichen. Vhen settled upon a branch covered with real lichen (bottom) the deception is perfect. The kind of mantis called Gongylus (top right), which omes from Southern India, is coloured like a flower and, when it hangs head downward as is its habit, poses as an orchid to ensnare its prey. South America produces a bug (top left) which develops leaf-like enlargements of its legs. Its official name is Diactor.

Martin Duncan

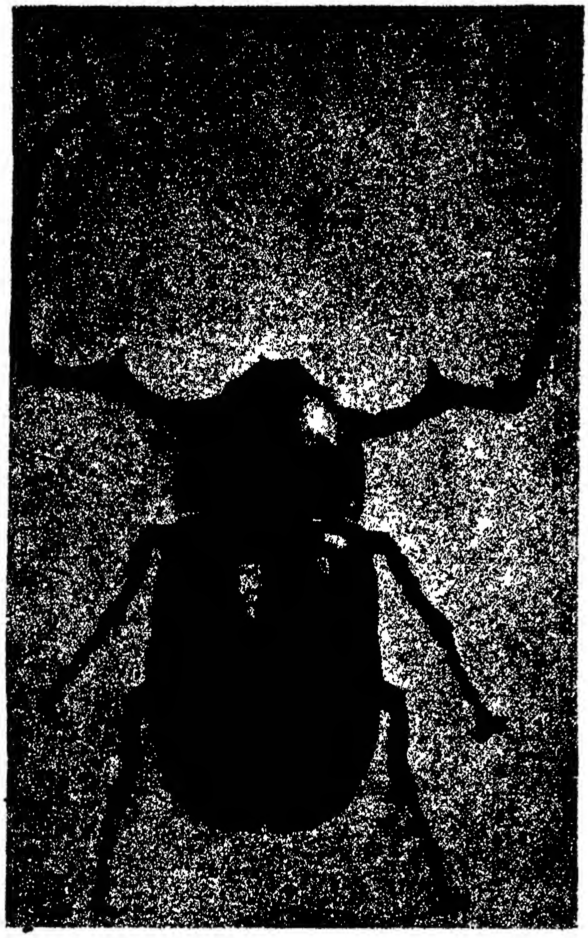
HOW THE MURDEROUS MANTIS IN ITS FAMOUS ATTITUDE OF PRAYER APPEARS TO ITS HAPLESS VICTIMS

As soon as some insect alights near a mantis this formidable creature which, while it remained motionless in its "praying" attitude was virtually invisible, begins to crawl very cautiously towards its intended meal. When within striking distance a surprisingly long foreleg shoots out, seizes the wretched insect and then the deadly killing apparatus on the third joint of the foreleg comes into action. As we see here, it is armed with a saw edge and the fourth joint, similarly equipped, folds back on to it like the closing blade of a penknife. The mantis then tears its prey to pieces with its jaws and, having devoured the meal at leisure, resumes its famous "praying" attitude in preparation for the seizing and rending of the next insect to come within reach.



HORNED SCAVENGER BEETLE AND LEAF-LIKE MANTIS

Brazil produces a scavenger beetle (bottom) armed with a single up-curving horn and armoured like some weird war-machine of an imaginative novelist's fancy. This is one of the very strangest forms in the beetle world. The upper photograph shows us yet another form of mantis which should be compared with those seen in previous pages of this chapter. It has leaf-shaped prothorax and elytra, or wing cases, and thus is able to disguise itself very effectually from the insects on which it preys.



E.N.A

SAWYER AND PAINTER BEETLES

Below we see a weirdly fashioned sawyer beetle with the two serrated horns on its head and its widely spread front legs. Above is a long-armed painter beetle, which has an enormous span to its forelegs and a heavy, thick-set body.

together with threads of silk, and has a soft, silken lining. In its perambulations in search of food the Psyche trails its case behind it wherever it goes, holding firmly to the inner lining with its hooked hind-feet so that only its head and scaly fore-legs are to be seen by a keen observer protruding from underneath the little bundles of leaves.

Another large foreign species constructs a long, tapering case of fine grass blades all cut to a given length and most neatly and symmetrically arranged. Chips of wood, fragments of straw, little bits of stick, lichens or mosses, and particles of earth are used by others to form their habitations, and one Asiatic Psyche makes a beautiful little case entirely of silk in the shape of a small, flat, snail shell.

From time to time, as the larva grows, it enlarges its case by adding to it a fresh row of its favourite material; and should an accident befall it the industrious insect at once sets to work to repair the damage by mending the rent, or fitting in a neat patch. When ready to undergo its transformation the larva carefully closes the larger end of its tube, and having thus secured itself against intrusion, changes into a chrysalis.

So, still protected by its handiwork, the little creature rests until its metamorphosis is completed. Then, if the insect is a male, a small delicate moth emerges from the case and flies away to enjoy a brief period of liberty in the open air. But if the moth is a female she does not leave her prison. She is wingless, and sometimes legless as well, in fact, little more than an animated egg-bag; she lays a quantity of eggs and, her mission in life accomplished, she at last crawls forth only to die.

The old case now becomes a nursery, but the baby caterpillars do not inhabit it for long. Almost immediately after they are hatched the tiny creatures make their escape and each one sets to work without delay to make a little case for itself exactly as its parents did before it.

In most cases, no matter how bizarre in appearance, or odd in its ways an insect may be, its eccentricities have, obviously, some direct bearing on its own peculiar mode of life; but there are some instances in which, to the ordinary human mind, these idiosyncrasies appear to have no special significance—though doubtless if we could see them from an insect's point of view we should find they were important in one way or another.

Of what use, for example, can the huge, misshapen proboscis of the lantern-fly (*Fulgora laternaria*) be to the insect? It was at one time supposed to be luminous and to shine forth like a lantern at night—but this idea was proved to be erroneous. The use of the proboscis is still a mystery.

Among the vast number of extraordinary beetles to be found all over the world none is perhaps more remarkable in shape than the singular violin beetle (*Mormolyce phyllodes*), or the "fiddler" as it is sometimes called. It is a native of Java and China, where it lives in the forests hiding under the bark of fallen trees. It is so surprisingly flat and thin that it can squeeze its body into the narrowest crevice, while its general shape and highly-polished, dark brown colour give to the insect the strange likeness to the musical instrument from which it takes its name.

Chapter LXXIII

Horns of Beauty and Horns of Strength

By Frank Finn

Author of "Wild Animals of Yesterday"

There is a well-known old story about a French student who tried to play a practical joke on Cuvier by dressing up as the devil, with tail, cloven hoofs, and horned and fanged mask, and arousing him from sleep with the words, "Cuvier, I've come to devour you!" To this impertinence the great scientist replied, "Horns and cloven hoofs with carnivorous dentition! An impossible combination—you can't do it!"

It is not quite so easy to be positive nowadays about what is a possible combination of characters. Cuvier would have been astonished to know of such a beast as has since been discovered, with paws and the general structure of a carnivore and herbivorous teeth—the opposite combination. But the story will serve to introduce two important points in connection with horns—their correlation with hoofs, especially with the two mutually-adjusted hoofs we know as the cloven hoof, and the paradoxes which really are often associated with them.

We may take as the first of these the fact that horns are very rarely wholly made up of the substance we call horn, and that the animals which are provided with such are not successful in the struggle for existence. For rhinoceroses are the only beasts whose horns are solid horn all through, and rhinoceroses are some of Nature's failures. All the living kinds can be counted on the fingers of one hand, and man has met but one other in life—the extinct woolly rhinoceros of the North, the portrait of which he drew in his old Stone Age days.

Rhinoceroses have always been rare in captivity, and one curious point about their behaviour in this condition may be noted—the fact that the captive Indian rhinoceros has a trick of grinding its horn down to a flat plate against any hard surface, while the common African rhinoceros leaves it alone. The great so-called white rhinoceros has never been exhibited alive; this has the largest horn of all of them, in the case of the first of its two horns.

Asiatic rhinoceroses have no doubt been much reduced owing to the idea that the horn was a poison-indicator when fashioned into a cup which, it was believed, would split if poison were poured in; for such an idea would naturally induce a brisk demand, and it probably arose from the fact that the solid horn was a type of what is true and genuine.

The Indian rhinoceros was the original of the so-called unicorn, but to make this mythical beast there has evidently been some confusion with a long horned antelope, and it has besides been given a horn, from a widely-different beast, which is not a horn at all, but the long, straight, spirally-grooved tusk of the small whale we know as the narhwal. That two quite different creatures can be mixed up in the mind was proved to the writer when he heard a woman visitor to the pond by the Palm House at Kew speak of a mandarin drake as a gold pheasant!

The rhinoceroses are the only hoofed animals with actual horns outside the cloven-hoofed section of the group, but it is a curious fact that in rare cases the horse, presumably as a legacy from the past, shows a tendency to develop them, two bony bosses appearing on the forehead under the skin.

W. S. Berridge

HORNS OF THE MUSK OX

With the musk ox the horns are curiously flattened against the head and almost look as though the fibres of which they are made had been first brushed hard and then had set. This formation turns the head into a powerful battering-ram at need.

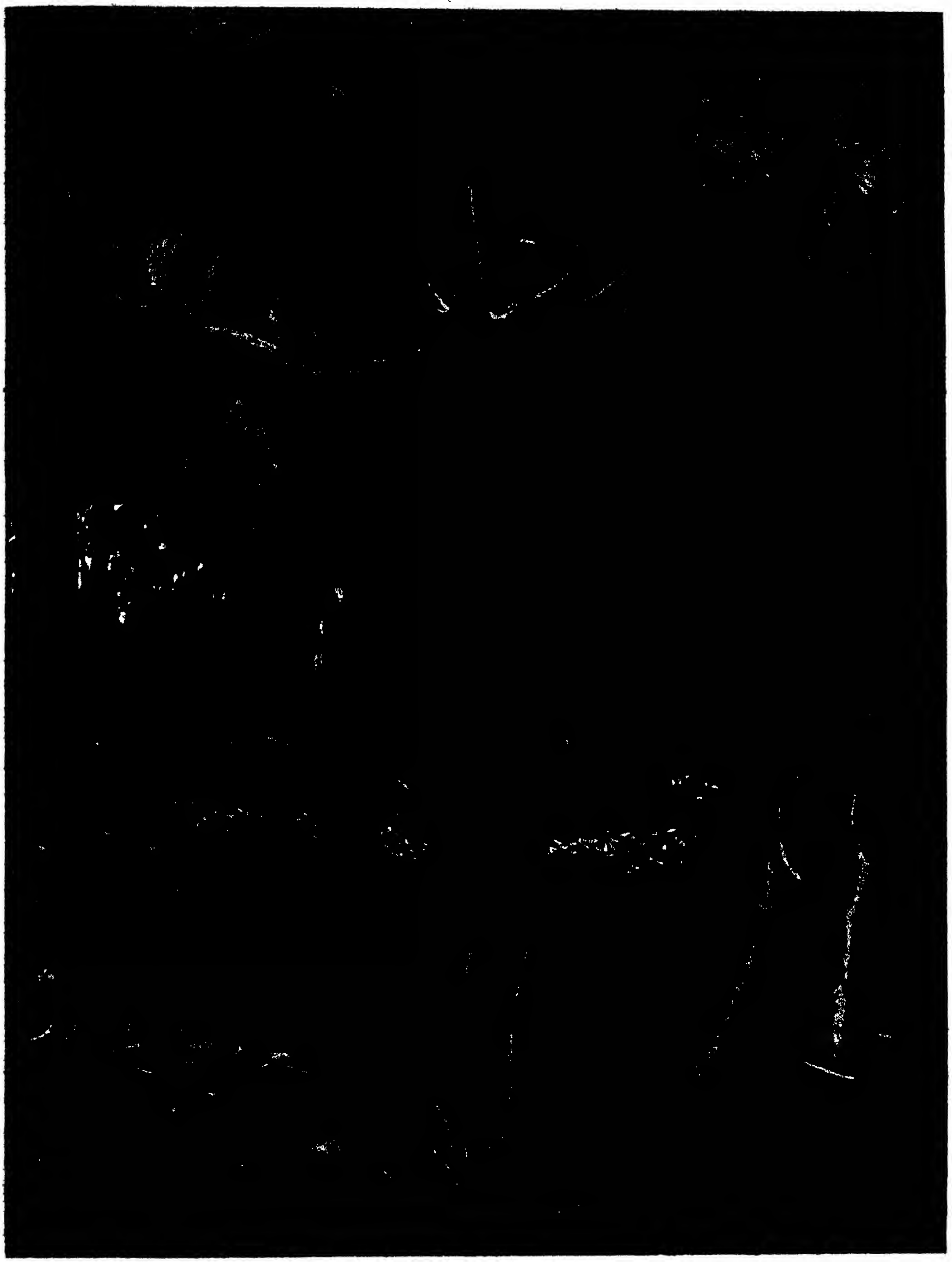
But this development, if it proceeded further, would result in the formation of a different type of horn from that of the rhinoceroses. It has done so in the giraffe, in which conspicuous though short horns exist, which are always covered with skin. Here not only two are found, but a central one lower down and less developed may occur, and even two in addition to this. In the giraffe's more primitive relative, the okapi, the female has short, skin-covered stumps, but in the male a cap of bare bone projects from the top of these, thus foreshadowing the state of affairs in the deer family.

PROVIDING the most numerous and varied of the horn-bearers is the bovine family, which includes not only the true bovines or oxen, but the sheep and goats, the capricorns or goat-antelopes, and the vast and varied assemblage lumped together as antelopes, most of which look like deer, though some, like the gnus, are horse-like, and others, like the elands, remind one of oxen. All of this family display horns which, in spite of great variety, agree in their plan of structure. They are plated articles, consisting of a core of bone covered by a sheath of horn, which may be either smooth or marked by raised rings or lumps. Many of these horns are exceedingly beautiful, and it is difficult to say which is the finer, the backward scimitar sweep of the sable antelope and the ibex, or the wide-flung corkscrew spiral of the koodoo and the markhor, to say nothing of the massively simple open curves of cattle horns or the bold circular turns of the giant sheep or argali.

Other patterns verge on the grotesque, like the zigzags of the hartebeests and the vicious-looking pot-hooks of the musk-ox, which is one of the capricorn group, despite its appearance.

CAPTIVE INDIAN AND AFRICAN RHINOCEROSES

When in captivity the Indian rhinoceros (bottom) has the strange habit of rubbing its snout against any hard surface so that the horn gradually becomes worn down to a flat plate as seen here. The African rhinoceros (top) has two horns. Of the hoofed animals whose hoofs are not cloven, the rhinoceros is the only one possessing a horn.



HUGE PALMATED ANTLERS THAT ARE BORNE BY THE MOOSE

Enormously heavy plates of horn armed with strong spikes make up the armament of the moose. It was this type of horn that was possessed by the extinct giant fallow deer of Ireland, whose remains are sometimes dug up. These have yielded some of the finest antlers known and have been found measuring four feet across with palms as large as the seat of a big chair. The moose, possessing this type of heavy antlers, has them perfectly set on the head so that the balance is just right.


W. S. Berridge

HEAD OF BLANDFORD'S SHEEP FROM BALUCHISTAN

This is a variety of the Urial, or Punjab wild sheep, and is distinguished by its very wide-spreading horns. These are prominently ridged and their curves make, in the case seen here, an arc that is considerably more than a semicircle. The bold simplicity of their sweep is magnificent, and the well-marked ridges add to the appearance finely. No wonder that so much trouble is taken over the obtaining of a fine pair like this as a sportsman's trophy. Blandford's sheep is found in the wilds of Baluchistan.

In the musk-ox and the African buffalo the horns expand and often meet at their bases, forming a strong shield for the forehead. In the Indian buffalo the horns are triangular in section, and attain a great length in some cases, especially in the cow, which has longer if less massive weapons than the bull. A horn of this species is known which actually exceeds six feet six inches in length.

As a general rule, the males of these hollow-horned ruminants bear larger horns than the females, but they may be hornless altogether, in which case, if of the usual deer-like shape, they are difficult to distinguish from female deer, unless one knows the particular species of both families.

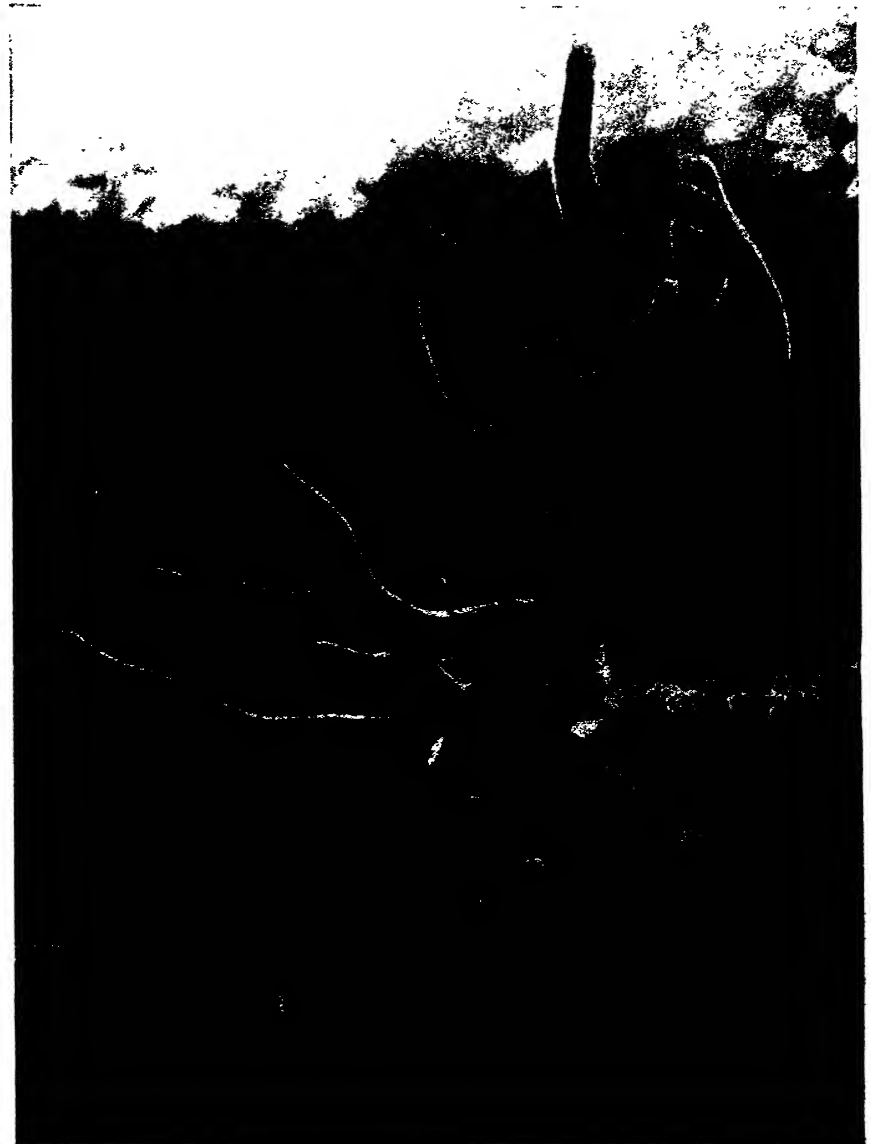
The power these arms confer on their wearers is very great. Even the lion has been found dead along with his prey, when this has been the oryx antelope which has impaled him on its long, bayonet-like horns, and the sable antelope at bay has been known to inflict casualties on dogs at the almost incredible rate of eight to the minute.

This beautiful creature is also so quick with its weapons that it can even parry flung assegais with them; yet it is not so ready to fight as its shorter-horned but larger relative, the roan antelope, which is apt to lose its temper and charge if driven too hard. On the other hand the koodoo is said to have no idea of making use of its fine horns in defence, and the writer has known the markhor, also gifted with grand spiral weapons, knocked out by a mouflon ram far less than his size, though the markhor's relative, the tame goat, can certainly hold his own with the tame ram.

More, however, depends on the courage of the individual species than on its armament; the African bush-buck, hardly larger than a goat, and short-horned, is a notorious fighter, and the Himalayan serow, a clumsy-looking capricorn with horns no longer than his donkey-like ears, has been found dead along with a whole pack of dholes—the terrible "red dogs" against which not only other horned animals, but the leopard, the bear, or even the tiger, cannot stand. The canine pack, indeed, seem to inspire a peculiar and unnerving horror in their prey; the cats stalk and spring, and kill or miss, or, as we have seen, may be killed themselves; but to be run to bay by the long relentless pursuit of numbers is an ordeal which requires the highest courage in the victim if it is to hold its own at the final encounter.

SHEEP WHOSE GREAT HORNS MAKE THEIR BODIES SEEM SLENDER

Of all sheep the argalis are the largest and they are found in Siberia, Mongolia and Tibet. We have a fine specimen here (bottom) with curving, wrinkled horns which make the body seem almost slender and rather deer-like by contrast. The upper photograph is of a Barb. sheep, a native of the mountains of North Africa. Its distinctive feature is a kind of beard which grows on the forequarters and hangs do well below the knees The horns are smoother than those of the argali, lacking the prominent ridges of the latter



W. S. Berridge.

HOOKED HORNS OF THE CHAMOIS AND BRANCHED REINDEER ANTLERS

The chamois, or izard (left), of the higher and more isolated mountains of Europe, is distinguished by the structure of its horns from the other goat-like antelopes. The horns are set close together and rise almost vertically from the head till they suddenly bend back to form a hook. The chamois herds keep to the high woods in the winter and feed largely on lichens and mosses, while in the summer they live just below the snow line. Persecution has sadly reduced their numbers. The reindeer (right), with antlers like coral branches, is distinguished in its armament from the other deer by the fact that the brow-tines are palmated and also in that both sexes have antlers.

W. S Berridg

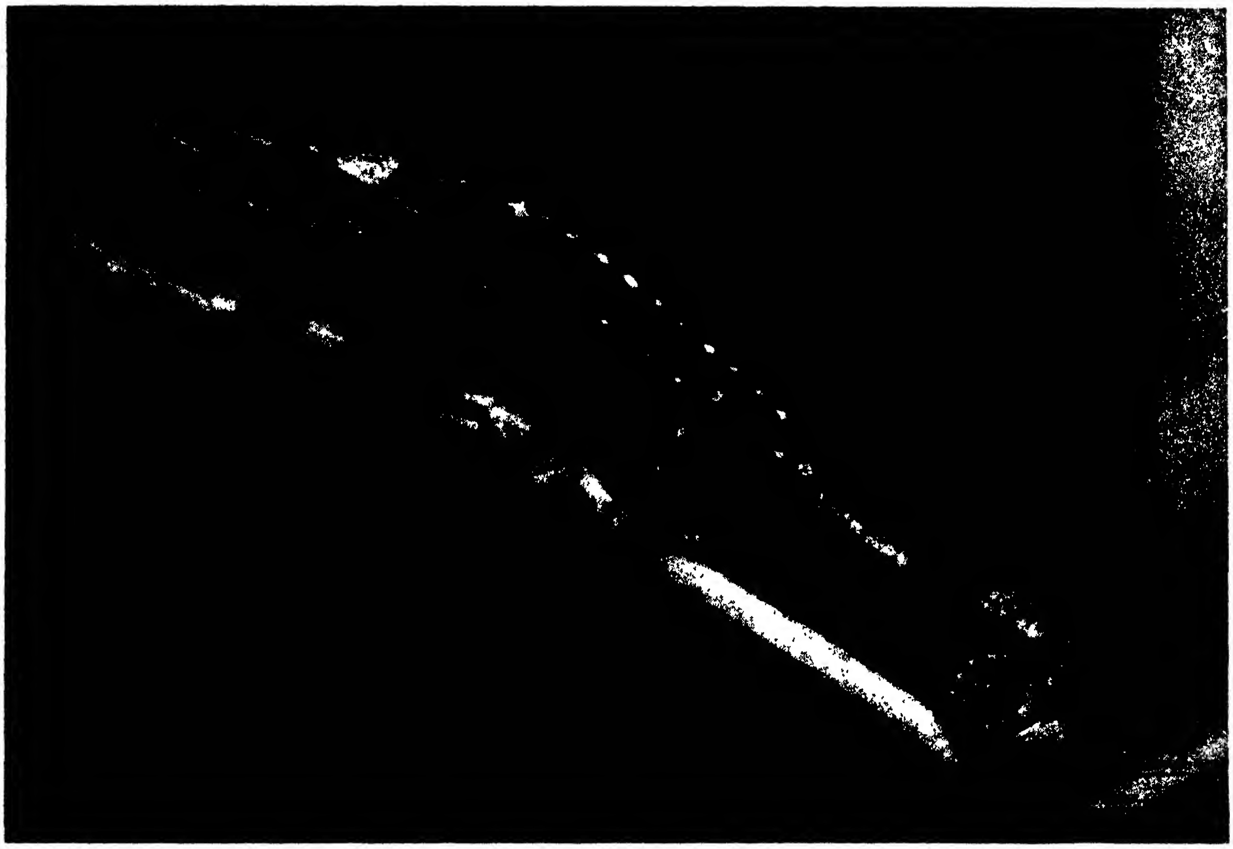
TALL HORNS, RIDGED AND TAPERED, OF THE SABLE ANTELOPE AND BEISA ORYX

A good head of a sable antelope is one of the sportsman's dearest prizes. The horns are particularly fine and sometimes grow to a length of four feet or even more. They are thick and boldly ridged, and have a fine backward sweep to them. The head is black with white markings and there is a thick and handsome mane. Another very handsome head is provided by the beisa oryx (right). It will be noticed that the horns are ridged and that the ridges become more widely spaced towards the top and disappear altogether about half way up. Beisa oryx are found in large herds, and the sight of hundreds of their long, tapering horns all sloping one way makes as brave a show as a company of pikes in a historical picture.

W. S. Berridge

HORNS OF UNUSUAL DESIGN IN VARIOUS SHEEP

Nepal includes among its animals a strangely horned sheep called the unicorn sheep (bottom left). In this species the ra its horns joined at the base and united for rather more than half their length. The horns then curve away from each other slightly, only d inwards again until, finally, they actually cross at the tips. In the barwell sheep, both of the black-faced (top left) and white-faced (top right) varieties, the horns are set far back on the head and sweep forward The fourth photograph (bottom right) shows a sheep with quadruple horns.



W. S. Berridge

HORNED CHAMELEON AND ITS STRANGE HEAD

So far we have been concerned with horns which were made for defensive purposes. But here is an inoffensive and rather defenceless little creature relying on its colouring to escape observation rather than on any powers of retaliation when attacked. The horns are peculiar to the male and seem to be purely for show since they could be of no service as weapons and they are not known to serve any particular function. Horned chameleons are found in Central Africa. Some species possess three of these weird ornaments.

Thus it is that canines clear out a district in which cats live without seriously incommoding their prey.

That the large oxen should be formidable is only to be expected from their size; they would be dangerous foes if they had the merest stumps of horns; but they differ greatly in temperament, the buffaloes, both African and Indian, being far fiercer than most. Indeed, even tame Indian buffaloes will attack the tiger unprovoked when in a herd, and are often used for driving a wounded one out of cover.

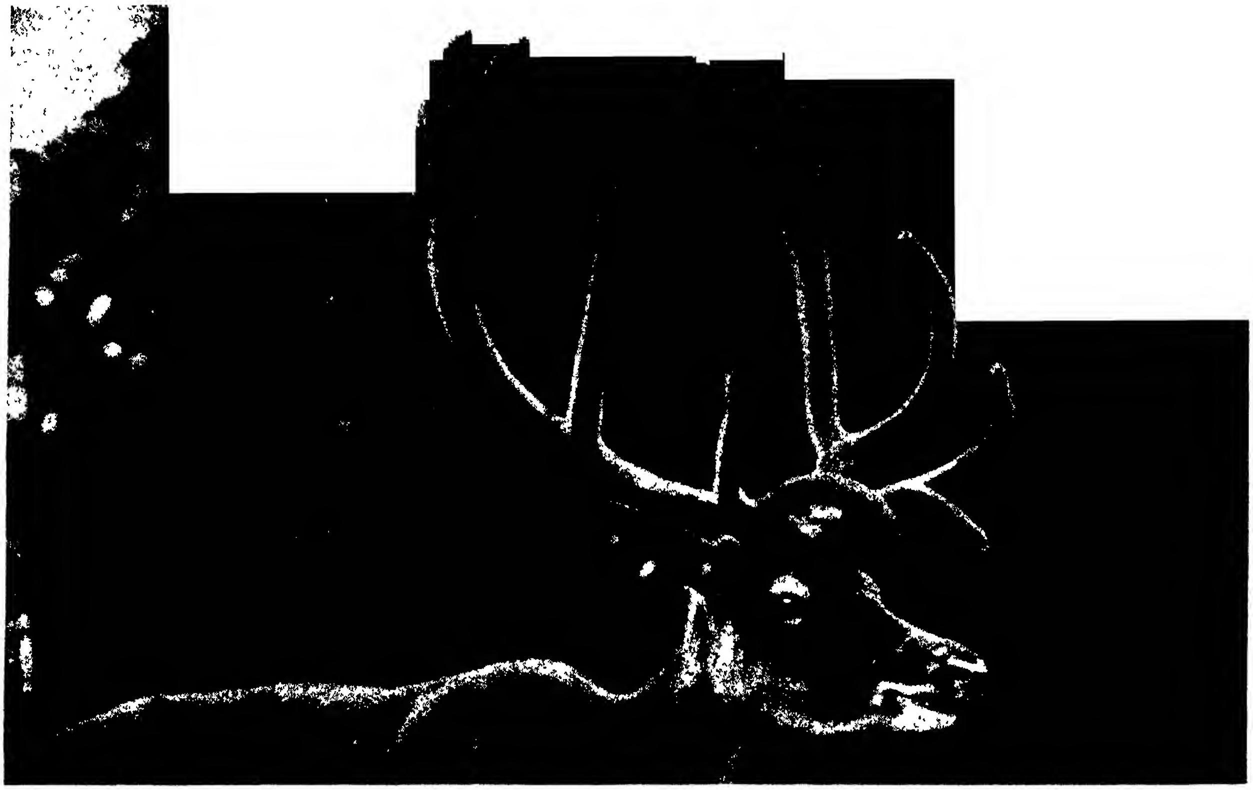
They dislike other animals, if strangers, besides this enemy, and perhaps, when they are attacked and sometimes killed by the gaur, or so-called Indian bison, they may have been "asking for trouble"; for the gaur, as far as man is concerned, is usually considered a harmless animal, whereas the wild bull buffalo is just the reverse.

There is, however, always a likelihood of warfare between two related species, and the writer once just missed seeing a really interesting bull-fight at the Zoo, because the fence between them held, though shaking perilously at each charge, when an American bull bison was trying to butt his way through to the English wild bull on the other side.

Many years ago one of these park bulls gave an example of the vicissitudes to which the wild warrior is exposed in nature; the second and third bulls conspired to depose their monarch, and handled him so roughly that he retired to nurse his injuries awhile; afterwards, however, he came out, killed one of his assailants, and regained his position. In a case observed in tame buffaloes in India, the master bull had to face three adversaries, and thenceforth was a very crestfallen and subdued beast.

Cases like this show that individual armature is not everything, and that cunning plays its part as well as strength even in contests between members of the same species.

The bovine horned animals mostly belong to the old world, but America has a few—the musk-ox, the Rocky Mountain "goat," one of the goat-antelope group, and in particular the American bison, which has achieved a greater reputation as a fool than as a fighter. Now and then, however, an animal with an extra good idea of looking after himself has occurred, and a redskin brave has had to gallop for miles to escape the determined pursuit of such an one; while a really beautiful instance has been recorded of a party of old bulls protecting a small



PERSIAN AND EUROPEAN RED DEER WITH MASSED ANTLERS

There exists this strange paradox about deer, that a deer's "horns," or antlers, are not made of horn, but of bone. Also, the deer with his antlers of many branches lives usually in forests where there is every kind of obstruction and impediment to progress for an animal so equipped. It is the open horned varieties, antelope and oxen, which inhabit open country as a rule. In Northern and Central Europe the red deer seem to have deteriorated in size, but in Asia representatives of the red deer family are large and fine like this example from Persia (bottom)

Neville Kingston

A HANDY USE FOR THE FAR-REACHING ANTLERS OF A REINDEER

Many animals can scratch their heads with their hind legs, but few have so fine an implement for relieving irritation in the hind leg itself as this reindeer of the London Zoological Gardens. This particular animal, which had formerly been quiet enough, suddenly developed a temper, attacked its keeper and smashed his wrist. The reindeer is one of the three kinds of deer which have developed the palmated or broad-ended type of horn, the other two being the moose and the fallow deer. Both sexes of reindeer bear horns.

weak calf from a band of wolves. The American bison is formidable from his great weight in front and from his speed, remarkable for an ox, but his horns are but poorly developed.

America has one beast called antelope, and a typical antelope in general appearance and in speed, which has the distinction of carrying a quite unique type of horn. The weapons are set far forward, over the eyes, in fact, and are hooked backwards like those of the chamois of Europe. But they resemble those of deer in being branched, though they have but one prong, far up on the front, and in being shed yearly, although they are composed of horn mounted on a bony core like the permanent horns of the family we have been considering. The core, however, does not extend into the prong and hook, and the mode of shedding is quite different from what is found in deer, the old horn being forced off by a hairy growth beneath it, while those of deer break off, leaving raw wounds. The prong-buck, as it is often called, has had a hard struggle for existence both with wolf and man, and is now very rare and local. It is gratifying to know that it is being well looked after, and that the first observation of its unexpected horn-shedding was made by Abraham Bartlett at the Zoo in London.

As, however, the prong-buck's horns are only about a foot long as a rule, their shedding is a small matter compared with the same process in the deer, whose armament may measure several feet and weigh several stone. In fact, in the deer we come to the zenith of efficiency and of beauty in animal weapons —and of paradox, for a deer's " horns " have no horn in them at all. They are pure bare bone, though, when soft and growing, covered with the plushy-haired skin known as " the velvet." At this time they are sensitive, and this must help to teach the stag how to keep his head clear of the boughs, for one of the deer paradoxes is that these creatures with their branching crowns do not inhabit open country as a rule, but keep to the woods, while the hollow-horned ruminants with their simple horns are found away from them more often than not.

Deer appeared earlier in evolution than these rivals, and in some ways still are more primitive—there are,

W. S. Berridge

BUFFALO OF NEPAL AND WIDE-SPREADING HORNS OF AN OX OF SPAIN

Curved like scimitars, the horns of the wild Chittagong buffalo of Nepal (bottom) are terrible weapons indeed. The upper photograph shows a simple type of horn—smooth on the outside and built up round a core of bone, as all bovine horns are. The owners of these enormous horns are the Spanish cattle of which the above is a Zoo specimen. In the days when drinking cups were made from horns, such a pair as this would have been a real prize. As musical instruments, too, they suggest great possibilities.

W. S. Berridge

WILD GOATS: NUBIAN IBEX AND HIMALAYAN MARKHOR

Some of the ridges in the horns of the Nubian ibex (bottom) are so pronounced that these weapons seem almost to have a saw edge. This wild goat is famous for the backward bend of its horns. The markhor (top) is another species of wild goat and lives in the Himalayas. It is about the largest goat in the wild and possesses magnificent horns, each one formed in a bold spiral. Five feet is the measure of some of these spirals, and besides this the male has his head further enhanced by a handsome beard.

James

HORNS OF DEER, WILD GOAT AND ANTELOPE

Branching like a candelabrum the spiked antlers of the wapiti (bottom left), the American and Asiatic representative of the red deer family, are as dangerous as beautiful to see. The upper branches are probably used as guards when fighting, the deadly blows being given by the dagger-like tines on the forehead. The other photographs show (bottom right), the Grecian ibex, a wild goat which has very massive horns for its size, and two members of the antelope family, the African eland (top left) and the Arabian gazelle.

STRANGE HORNED SCREAMER OF THE SOUTH AMERICAN LAGOONS

There are several strange things about the bird called the horned screamer which is found only in South America. In the first place, it possesses a curious growth of horny substance, about five inches long, upon its brow. It is the only one of the five species of screamer which possesses such a thing. The birds haunt lagoons in enormous flocks and are in the habit of screaming all together in a chorus When a number o flocks do this in turn the neighbourhood is apt to become intolerable

for instance, two deer, the musk and the Chinese water-deer, which have never developed horns at all; nor do the females normally develop them, except in the case of the reindeer, and not always in this, for in Kazan reindeer hinds are hornless. The ugliest and most unpractical antlers are borne by the reindeer-like milou or Père David's deer, and have no tines in front, but a huge one at the back.

There is remarkably little difference in appearance between the little duyker-bucks of Africa and the little deer of South America known as brockets; only the little single-spike weapons stay on in the duykers and are shed annually in the brockets. Starting from these, all stages in the evolution of the deer antler may be found still existing, and paralleling the stages through which the young stag goes; for species with well-branched horns always begin with a single spike and add branches each year till the full coronet of antlers is assumed.

Next to the brockets we get the Chilian huemul, which has two spikes, like the Asiatic muntjac, which also has two, but mounted on high, bony supports. This is really a more primitive type, for it has well-developed canine teeth, and trusts to them in fighting more than to its little antlers.

A further evolution gives us antlers of the type borne by the Indian sambhar and spotted deer, with a brow tine near the forehead, a long beam or main shaft, and a couple of spikes on the top or crown. This is probably all that is required for efficiency, the brow tines being the daggers by which deadly damage is done, and the tops or crown-points the fencing weapons which keep the enemy from pressing his attack home.

But evolution appears to have run riot in deer's antlers as it has in the comb of the domestic cock, and gone beyond what is practical. For instance, in the beautiful antlers of the red deer, and his great ally the wapiti of eastern Central Asia and of America, we get a "bay" tine, which is merely a duplication of the brow tine and situated just above it, and a "tray" tine which, placed as it is about the middle of the beam, is hardly likely to come into action.

As an example, however, of the terrible efficiency of these weapons there may be quoted the case of a foolhardy trespasser who was killed in Caton's deer park in the United States by a wapiti stag, in spite of the efforts made to save him by several men armed with pitchforks which the stag kept off with the ends of his antlers while he gored his victim with the brow tines.

Casualties among deer themselves when fighting are remarkably rare. A deer duel consists mostly in head-to-head wrestling, and the beaten stag generally suffers by not being quick enough in getting away, and so laying himself open to a flank attack.

An occasional accident, however, brings death to both combatants—the interlocking of their antlers, which means death by starvation. This is particularly likely to occur in the common white-tailed deer of North America, which, like most American deer, has no brow tine, and has a forward-curved beam well provided with spikes. But it may even happen with the comparatively simple palmate antlers of the moose, and a pair of moose antlers thus locked are among the treasures of the Royal College of Surgeons Museum in Lincoln's Inn Fields, and date back to the time of the great John Hunter.

The palmate or broad-ended type of antler has been evolved independently in three types of deer—in the reindeer and the fallow deer, as well as in the moose. In the first-named even one of the brow tines is palmate, and is known as the "snow-shovel," though said only to be used as such when the snow is crusted, the deer usually digging with his fore-feet, like the bison, sheep, and horse.

Palmate horns in the stag's earlier years are of the ordinary branched type, and it is to the palmate form that the finest known antlers belong—those of the giant fallow deer dug up below the Irish bogs. Though extinct, this noblest of the horned animals lasted down to Stone Age human times. Its weapons may span nearly four yards across, with palms as big as the seat of a chair, fringed with spikes each of which would make a presentable horn for a deer of average size.

It is possible, however, that the record for antler length is held by a modern deer, which justifies the poor angler's ridiculed plea that the biggest fish get away, in that he was never shot or even seen. This was a wapiti stag whose shed antlers were found by an exploring party in the United States in the nineteenth century. So huge were they that when set up on their tips so as to form an arch the tallest man in the party walked under this without touching.

It is a pity that, as the specimens evidently could not be carried away, more exact details were not recorded; but as the man could hardly have been less than five feet eight, and as several inches at least must be allowed for the curve of the antlers, they must have been over six feet each, and were quite possibly seven.

After all this, it seems strange that a stag can get on perfectly well in deer society without any horns at all; but deer seem to delight in paradoxes, and a "hummel" stag which never develops antlers may be herd master, overcoming his armed rivals by boxing with his fore-feet like a horse. Hinds also fight in this way, but such a means of defence seems not to have been successful in the long ages of evolution, for those families of hoofed animals which have never developed horns contain very few species even compared with the deer, which are far less numerous and far less varied in bodily form than the hollow-horned section. They have, however, held their own far better, in spite of the drain on the constitutions of the males by the yearly re-growth of the antlers, and in spite of not possessing the enduring speed and extraordinary springing power so common in antelopes.

Chapter LXXIV

The Mystery of the Cuckoo

By Oliver G. Pike

Author of "The Great Winding Road"

For nearly two thousand years the cuckoo has been a bird of mystery. The result has been that an enormous amount of controversy has raged around this interesting bird. At the present day, students of the cuckoo are divided in their opinions; there are those who say that when she deposits her egg in the nest of the fosterer, she does it with her beak, having previously laid the egg on the ground some distance from the nest. Others say that sometimes she lays her egg into the nest, and at other times carries it there in her beak. A very small minority, who need not be taken seriously, insist that no cuckoo ever has laid her egg direct into the nest.

From the very earliest times the generally accepted theory has been the first one mentioned, but this was completely shattered when Mr. Edgar Chance, after several years of intensive field-work, showed that several cuckoos which he had under observation laid their eggs direct into the nest in the normal manner like any other bird.

Notwithstanding his very conclusive discoveries, he met with much opposition from those who disliked the old theory being upset. Some asked how the cuckoo laid her egg into a fragile nest like that of the reed-warbler. Others mentioned instances of cuckoos' eggs having been found in the homes of the wren and chiffchaff—two small nests that are domed over with a small entrance at the side, far too small for the cuckoo to enter. A few of the more violent critics said that it would be necessary to photograph every female cuckoo in England if the new theory was to be proved, for some might lay into the nest, while others would carry their eggs to deposit them with their beaks.

Following the publication of Mr. Chance's book "The Cuckoo's Secret," I worked in conjunction with Mr. Chance, and together we produced a kinema film which proved beyond every shadow of doubt that the cuckoos which we photographed laid their eggs into the nests, after first stealing one of the original eggs. A wonderful slow-motion film was obtained which showed every detail of the cuckoo arriving, stealing the egg, and laying her own egg in its place, afterwards flying off with the stolen egg which she retained in her beak while laying. A series of most conclusive pictures was obtained at five different nests.

Since then others have watched various cuckoos, and some wonderful observations have been obtained. It has been found that whenever the watcher had obtained a clear view of the whole performance, on each occasion the cuckoo has been seen to lay direct into the nest. Observers have seen her lay in the nests of the following half-dozen species of birds: tree pipit, meadow pipit, rock pipit, yellow-hammer, pied wagtail, and reed warbler.

I have seen a cuckoo flying round a hedge-sparrow's nest in which there were two eggs of the owner bird. I had a clear view of the cuckoo when she went to the nest, and there was definitely no egg in her beak. Less than ten seconds later the nest contained one hedge-sparrow's egg and one deposited there by the cuckoo. There was no doubt in my mind that she laid it. This rather imposing list contains most of the chief birds that the cuckoo uses as a fosterer, and it goes far to prove Mr. Chance's and my belief, that all cuckoos lay into the nest and do not deposit the egg with the beak.

Some very careful naturalists have made observations where eggs of the cuckoo have been found in small domed nests. I have watched the cuckoo lay many times; I have been very near the bird on each occasion, and I have come to the conclusion that she would have very little difficulty in laying into these nests by holding on to the sides with her claws, then laying the egg into the entrance. It has been noticed that when eggs are found in such nests, the front or sides of each has been disturbed where the cuckoo evidently clung to the exterior. At some of these nests the cuckoo's egg has been found just outside, which goes to prove that when she attempted to lay the egg through the entrance she failed to do so and it rolled down and remained outside. If she had been placing it there with her beak, and happened to drop it, she would not have been so foolish as to leave it lying outside, but would have picked it up and made another attempt.

On one occasion we surrounded a pipit's nest with thorns and twigs, leaving a little hole at the entrance through which the cuckoo could place her egg with her beak, but we made it so that the bird herself would have extreme difficulty to pass through the entrance. It was interesting to watch what happened when the cuckoo arrived. She first went to the entrance and found it was not possible to pass that way. In front was a flat space on which she could have easily laid her egg, to pick it up afterwards if she so desired. But the bird had no intention of doing this. She wished to deposit her egg in that nest, and the only manner in which she knew how to accomplish this was to lay it. She examined the gorse bush under which the pipit's nest was concealed, then she set about performing her allotted task. She settled on top of the bush and then, putting her head down, fought her way through the thorns. She lost several feathers as she went down, but reached the nest. I watched her first take one of the pipit's eggs, then she moved her body on to the nest, laid her egg and returned the way she came.

Another discovery goes a very long way to prove that this method is the one always used by the cuckoo. It was found that before laying her egg she sat for long periods on a branch of a tree or some other convenient perch. Here she remained almost motionless for anything from one hour to six hours, usually the longer period, and this corresponds to the time that other birds sit on their nests before actually laying. Directly she is ready to lay, she leaves her perch and *glides*, not flies, in a slow and careful manner to the nest. When she reaches it no time is lost. First she takes out one of the original eggs, quickly moves her body on to the nest and lays her own egg in its place, the whole performance seldom lasting more than ten seconds. She then flies off with the stolen egg, settles on a convenient perch, throws her head back and devours it. She swallows it rather ravenously, for if she has spent some hours on her perch before laying this is the first meal she has tasted for a long time.

It has been found that the cuckoo lays her egg every alternate day during the laying period. In the ordinary way she would lay about five eggs, and it is a great mistake to imagine that when she has performed this duty she forgets all about them. If her eggs are taken from the nest or destroyed in any way, she will do what other birds do under the circumstances, that is, lay again, and by taking her eggs directly after they were laid, one cuckoo was induced to lay twenty-five eggs in one season. She is not satisfied until she finds that her scattered brood is well on its way to being reared by the various fosterers. When success is assured, she and her mate leave the country.

THE story of the young cuckoo is one of the most wonderful in the annals of natural history. The period of incubation of the cuckoo's egg is thirteen days. When the youngster first hatches out it is blind, and, lying at the bottom of the nest, it appears as a little lump of black flesh. On the first day it takes no notice of its nest companions or other eggs in the nest, but on the evening of the second, or the morning of the third day, this helpless-looking infant becomes imbued with

A. H. Willford

YOUNG CUCKOOS APPROACHING ADOLESCENCE

During the adolescent stage the cuckoo's plumage is brown on the upper parts with a white spot on the back of the neck and grey markings. In the upper photograph note the characteristic swelling under the beak which gives an incongruous effect as of a double chin to the young bird.

marvellous strength and instinct. The remaining eggs, or perhaps young in the nest, represent future rivals for food, and this the cuckoo cannot tolerate. So the youngster empties the nest of all other eggs or young.

If there should be eggs there, his task is fairly easy, for he gets one upon his back, stands up, and rolls it over the side. With young, his task is more difficult, but he quickly accomplishes it. I have often tested the strength of young cuckoos with birds very much larger and stronger than themselves. At one nest of the reed-warbler that I desired to film, I found that the young cuckoo had forestalled me, and the three young warblers were lying dead under the nest. I found a young sedge-warbler in a neighbouring nest, which had feathers on its body, was twice the size of the cuckoo, and was able to see what was taking place. The cuckoo was still blind, but directly I placed the warbler in the nest a most wonderful struggle began. As I watched I could see that it could have but one ending. The cuckoo showed the most amazing powers of strength. It worked down in the nest until its companion was on its back, then, gripping the sides of the nest with its feet, it used the wonderful muscles on its legs and slowly but surely raised its burden. When it appeared to have reached the extent of its stretching powers, it opened the small, fleshy arms that would some day be two fine wings, and began to work these up and down. It also jerked its body upwards with violent movements, with the result that the warbler was flung ignominiously over the side of the nest. This amazing youngster now tumbled to the bottom of its home, worked round to see that there were no more rivals present, and then settled down to contentment and rest.

M. H. Crawford

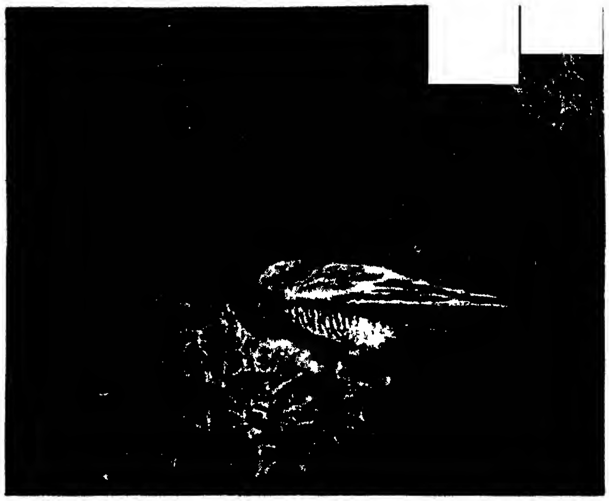
ADULT CUCKOO ON THE WING

Cuckoos are very fond of the various kinds of hairy caterpillars and are a definite check on the very destructive caterpillar of the garden tiger moth. This caterpillar is familiarly known as the " woolly bear," and will devour almost any kind of vegetation and, in some summers, becomes quite a local plague. The cuckoo's services as an antidote are then very welcome.

THE parents of insect-eating birds bring food to the nest at very short intervals throughout the summer day ; often less than a minute passes between the visits. The young cuckoo, therefore, obtains an enormous quantity of food, and this is necessary, for it is a quick-growing bird. Ten days later it is clothed in fine feathers and is considerably larger than the nest on which it endeavours to make itself comfortable.

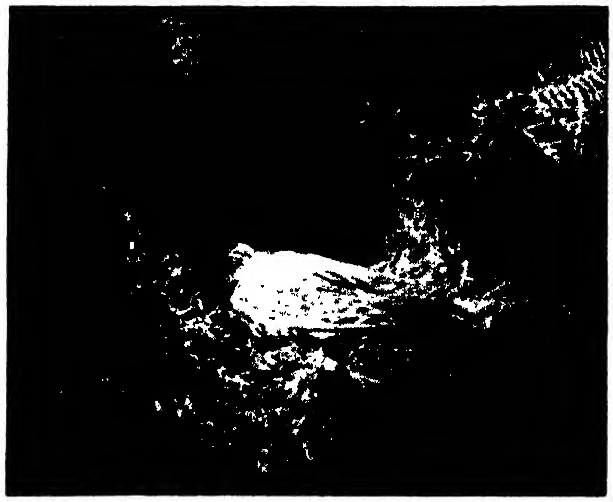
A few days later it opens its long wings and commences to fly, and as it travels from perch to perch the foster parents follow it. The baby will usually sit in fairly prominent positions, and occasionally utters a curious, high-pitched note. This seems to have a wonderful effect. Other birds in the district may be taking large beakfuls of food to their own young, but if they see the young cuckoo, or hear that peculiar cry, they pause in their flight, and give the food that they are carrying to the young cuckoo, and they will even return with further supplies. There was a record a few years ago of a cuckoo that was reared by a pair of hedge-sparrows being fed by five different species of birds, and I know of another instance in which no fewer than fourteen pipits were attending to one young cuckoo !

Cuckoo approaches nest

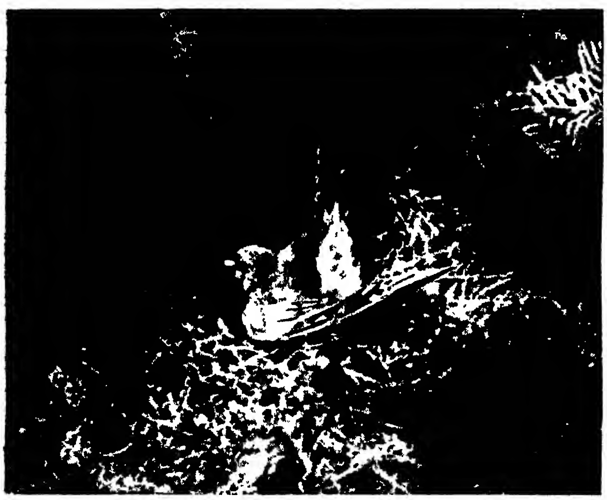


It seizes the egg inside

Holds the stolen egg in its beak



Settles on the nest



Lays its egg

Flies away with stolen egg

THE KINEMATOGRAPH CAMERA SOLVES THE ANCIENT CUCKOO MYSTERY

Until the kinematograph camera was invented and used in the naturalist's service the cuckoo mystery remained insoluble. But, with this new implement, the investigators were, after the expenditure of much patience, rewarded with conclusive evidence from the films they obtained. The bird waits near some selected nest until the time for laying her egg and then glides to the nest, removes an egg with her beak, lays her own very small egg and flies off with the stolen one which she devours. This story is fully told here in photographs by Oliver G. Pike.

CUCKOO CAUGHT IN THE ACT OF LAYING HER EGG

Having selected a meadow pipit's nest as a suitable place for the incubation of her egg this female cuckoo has flown to the nest and seized one of the pipit's eggs which we see here held in her beak. She is just in the act of laying her own egg, which is only about the size of a lark's, into the nest in place of the one she has just stolen. This egg she will soon swallow, for she has not tasted food for some hours while waiting on some nearby perch for her own egg to be ready for laying. This photograph is from a kinema film by Oliver G. Pike and E. P. Chance.

Oliver Pike

HARD-WORKED SEDGE-WARBLER ATTENDING TO HER GARGANTUAN CHANGELING

It is at once a marvellous and ridiculous sight when a young cuckoo, three-parts grown, is being fed by one of its foster-parents who may be only about one-third of its size. In the left hand photograph the young cuckoo, which is in the stage when it flies short distances from one perch to another and is followed about by its foster-parents, is sitting on a branch and looking up expectantly to the warbler who is always a giver of good gifts. On the right the cuckoo is showing the commodious dimensions of its mouth while the warbler is standing, with one claw raised as though in uncertainty, gazing at its insatiable great charge and, perhaps, wondering how this all happened.

A H. Willford

LUCKLESS MEADOW PIPITS FEEDING THEIR HUGE FOSTER-CHILDREN

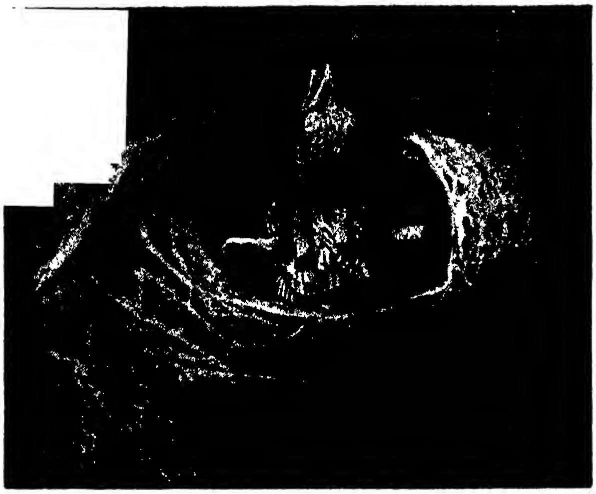
On the right is a photograph of a common sight where young cuckoos are concerned, the foster parent standing on the young bird for the sake of convenient feeding. The other illustration is remarkable for showing two cuckoos at once on the same stump. There is a record of no fewer than fourteen pipits attending to one cuckoo, and this despite the fact that they all had healthy, hungry young ones of their own squalling for nourishment at home. This remarkable bird seems to have the secret of charming other birds from their proper duties.

A H Willford

Oliver Pike

SEDGE-WARBLER FOSTER PARENT AND A MEADOW PIPIT'S CHANGELING

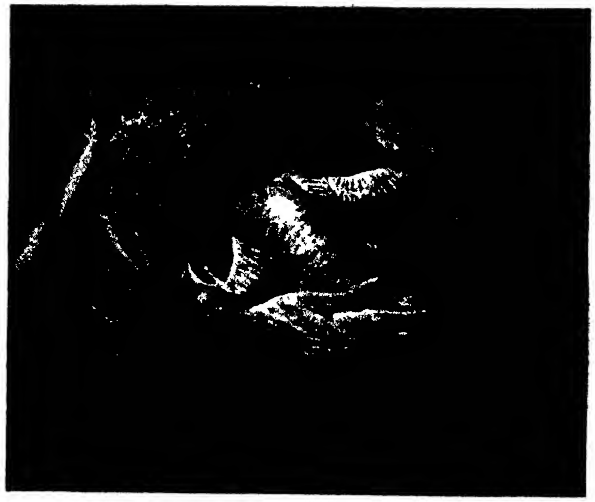
Cuckoos seem to prefer certain birds as nurses for the chicks they do not trouble to rear themselves. Sedge-warblers, pied wagtails, meadow pipits, and hedge sparrows—all small birds—are the most popular for the purpose, and as the cuckoo lays a comparatively small egg this can be accommodated in the nests of these birds. The lower photograph shows a sedge-warbler with a beak-full of insects, feeding the cuckoo which seems almost large enough to be able to swallow its nurse—insects and all. Above is a young cuckoo in a meadow pipit's nest.



Beginning of the struggle

The cuckoo gets underneath

The cuckoo spreads its wings



The rival pushed over the side

Going

Gone

THE CUCKOO IN THE NEST AND HOW IT BEHAVES THERE

So soon as ever the cuckoo is hatched out, it proceeds at once to dispose of any rivals. It needs all the available food supply and takes at least two birds, working whole-time, to feed it. If it finds it has hatched first, it heaves the other eggs out of the nest. If there are other fledgelings it adopts the method illustrated by the kinematograph illustrations above. The cuckoo gets underneath its rival and uses its strong legs to press itself upwards, thus lifting the other bird. Then, by agitating its wings, it hustles its rival over the edge. Photos by Oliver G. Pike.

A H Willford

CUCKOO BEING FED BY MEADOW PIPIT

The cuckoo is specially equipped for its nefarious system of up-bringing. It soon grows its feathers and starts to fly. The parents follow it about and bring food. Not content with this the cuckoo utters, from time to time, a peculiar cry which seems irresistible to other birds, for they come and bring it the food they were taking to their own chicks.

But at length the time comes when the foster parents become tired of following and feeding their great infant, and they leave it to get on as best it can. But now it is confronted with a difficulty. Most young birds, when they leave their nests follow their parents about, and learn how to collect their own special food, but the young cuckoo has been content to have all the food brought to it, and when it has to obtain its own living it discovers that insects, unless you know where to look for them, are difficult to find. It becomes very hungry, and eventually changes its diet and becomes a vegetarian.

The crops of twelve young cuckoos that had been deserted by their foster parents were examined, and no trace of insect food was found. Eventually these youngsters, that are so cleverly able to adapt themselves to their surroundings, find where the insects are hidden, and go back to their proper food. Five, eight, or even ten weeks after the real parents of the cuckoo leave the country these youngsters launch out on a long southern journey, eventually to reach Africa, where they spend the chief part of the year.

There is still much to be discovered about this interesting bird. But a word is necessary as regards those observers who say they have seen cuckoos carrying their eggs in their beaks. The cuckoo is a confirmed egg thief, and on her non-laying days spends quite a lot of time in searching for and raiding nests. I have watched her take and devour eggs from the nests of the yellow-hammer and skylark, and a casual observer might easily think that she is carrying her own egg, while as a matter of fact she is simply carrying the food she has discovered to a comfortable and convenient perch.

Many observers have seen a cuckoo standing at a nest with an egg in her beak, and with the old theory firmly implanted in their minds, they have thought it was her own egg that she was about to place in the nest. If these instances could have been properly investigated, I firmly believe that in every instance it would have been found that the egg she was holding was the one she had stolen from the nest previous to laying her own in its place. No one, as yet, has been able to bring forward satisfactory photographic proof, that is, with Kinema films, that a cuckoo places her egg in the nest with her beak.

When we sum up all the evidence we cannot help asking whether the naturalists of the past have not made a great mistake, and been rather prone to follow in the footsteps of their predecessors, accepting their statements without taking the trouble to investigate for themselves. In the light of modern discovery, observers of all kinds should start afresh, obliterating from their minds all previous theories. It is only by doing this that we shall be able to steal the cuckoo's secret from her, and prove a much debated problem.

It was not until the invention and perfection of the Kinematograph camera that so vexed a question as this could be really satisfactorily solved. One by one, the wise saws of old give way to modern instances—obtained with the help of ever increasing science

Chapter LXXV

Living Rainbows

W. P. Pycraft

Author of "The Seashore"

WHY it is that some animals have developed coloration which resembles the iridescence of certain metals no man can say. And the matter is rendered the more remarkable from the fact that this gorgeousness is not due to pigments answering to the hues displayed, but to a modification of the surface-structure of the feather, or hair, or scale, as the case may be.

How this metallic appearance is produced in a feather may well serve to illustrate the similar cases in other creatures. In birds then, where these shimmering hues are present the "cilia," or thread-like investment of the surface, are wanting; and the metallic areas are formed of rows of compartments covered with a transparent horny layer, often overlapping like tiles: and this transparent layer is backed by a black or brownish-black pigment. In some cases the outer case is smooth, but it may be polished or engraved with fine, wavy, longitudinal ridges; or small dot-like irregularities may take the place of lines. But in all cases the outer transparent coat acts just like a number of prisms.

All metallic feathers appear black when the surface is parallel to the rays of light and at the same level as the eye and the light. As one changes the incidence of the light, as in the king bird of paradise for example, the feather passes from black to light coppery red, then rich green: while in the beautiful *Pharomacrus moccino* —one of the trogons—it changes from black to greenish-bronze, through golden-green to green, from green to indigo, then to violet. In one of the humming birds, *Oreotrochilus chimborazo*, the whole solar spectrum is displayed—violet and red on the head, followed by orange and green on the back—blue, violet, and lastly, purple on the long tail feathers.

Most of us, I think, when we see the limelight thrown on a performer on the stage, are moved rather with the effect produced: and take no thought for the mechanism which produces it; and so here, it is the sheer beauty of the vivid and ever-changing hues which fascinates us, and not the wonderful underlying mechanism.

But these spectacular effects gain an added interest when an endeavour is made to discover what lies behind them, so to speak. Now in birds we find these effects always associated with the males, which seem not only conscious of their splendours, but convinced that, properly displayed, they will prove a sure and certain means of securing the favour of their mates. This may, indeed, be an inference well founded. It would not, however, be

all animals thus resplendent are animated with a like desire, for there is no evidence that the exquisite hues of certain butterflies, to be mentioned presently, are in the slightest degree appreciated by the wearers, or by the females. But we must take our facts as we find them, and not strive to make what is evidently true of one group of animals apply equally to some

F. W. Bond

MACAW AND ITS RADIANT FEATHERS

This is a red and yellow macaw which is native to the Amazon forests and the northern parts of South America. The prevailing colour is a dark, rich red and its brilliant plumage makes it a favourite in aviaries. It will live ten years or more in captivity.

W. S. Berridge

BRILLIANT HEAD OF THE BLUE AND YELLOW MACAW

This bird was noticed by sixteenth-century explorers of South America, and its bright uniform of orange-yellow and green together with its conversational powers make it one of the most popular of the macaws to-day. The forehead is an olive-green and the back of the head green-blue, while the cheeks and throat are marked with a black stripe. The sides of the head are yellow. The blue and yellow macaw is found between Bolivia and Honduras and is essentially a bird of the tropics. It is very quick, as a rule, to pick up words and phrases.

group which we know as holding a widely different position in the scale of life.

The birds, as I have said, seem conscious of their beauty. Look at the "peacock in his pride." Having set his gorgeous train in order, he approaches his apathetic, and seemingly unappreciative, mate, backwards; so that she sees nothing but a great, grey screen. As soon, however, as he deems himself sufficiently near, he swirls round and faces her, then sets all the "train" feathers vibrating so that they give out a sound like the pattering of rain on leaves, and caps the performance with a wild scream! If we need evidence of "consciousness" of beauty, and a deliberate desire to exploit it, we seem to have it here.

TURN again to the Amherst and golden pheasants. I need not attempt to describe their splendours in detail; but will instead draw attention to that wonderful "frill" of exquisitely coloured feathers which surrounds the neck. When they are "courting" this frill is made to play a great part. The bird is an accomplished artist. He presents one side of himself to his mate, and gives a twist to that frill so as to bring most of it over to the side facing her, spreading out the long and resplendent tail at the same time. But note it is not spread like that of the peacock, but kept close to the ground, and spread sideways, while the wing on that side is half opened. Here, again, there seems to be a deliberate, conscious effort to make the most of his charms.

I know of no records of the "display" of the impeyan pheasant of Kashmir, which furnishes one of the most striking examples of metallic plumage among birds, for every feather of its body looks as though it were made of iridescent metal.

When we turn to the birds of paradise we are faced with such a galaxy of splendour, and such amazing methods of displaying these splendours, that the task of describing them almost induces a state of mental paralysis! Yet I would attempt the feat were it not for the fact that I want rather to draw attention to broad facts than to dwell upon selected cases.

Why is it that among some groups of birds, like the birds of paradise, the sun-birds, and the humming

MANDARIN DRAKE, A LIVING RAINBOW OF PLUMAGE, AND HIS MATE

In birds it is usually the male which displays the more brilliant livery, and this is generally heightened in beauty during the mating season. The mandarin duck is found in Eastern Asia and the male is particularly remarkable for its wonderfully tinted plumes. One of the scapular or shoulder feathers is upturned to form a fan upon the back, and this fan is a bright brown and banded as though with imperial purple.

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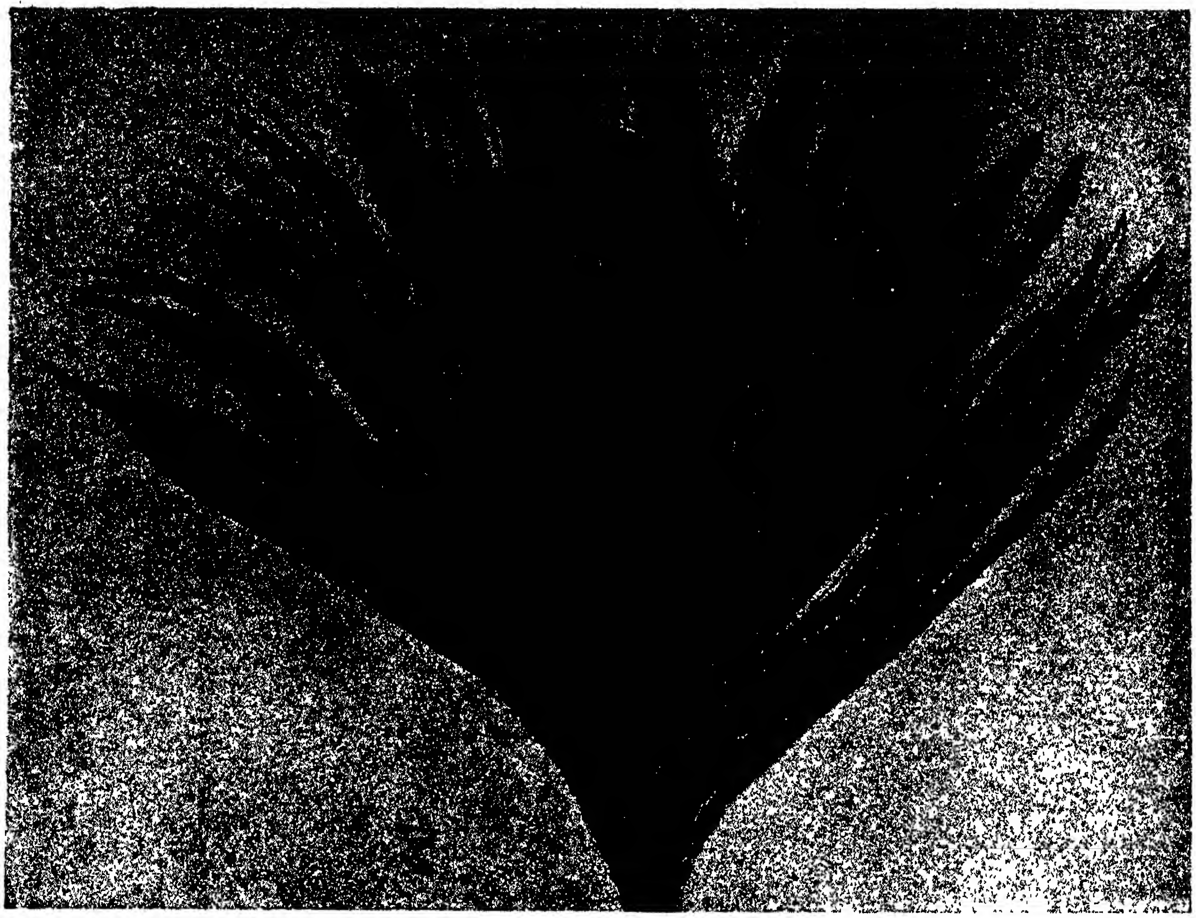


PEACOCK'S FEATHER WHOSE SPLENDOUR IS NOT DUE TO PIGMENTS

The remarkable iridescent hues seen in a peacock's feather are not due, as might be supposed, to the presence of any pigments answering to the tints displayed, but to a modification of structure in the surface of the feather. That there is no pigment present can easily be proved by holding the feather parallel to the rays of light falling on it, when it will appear black. The parts of the feather which display the metallic colouring are formed of rows of minute compartments covered by a transparent layer and this layer acts like a number of prisms, thus producing the rainbow effects.

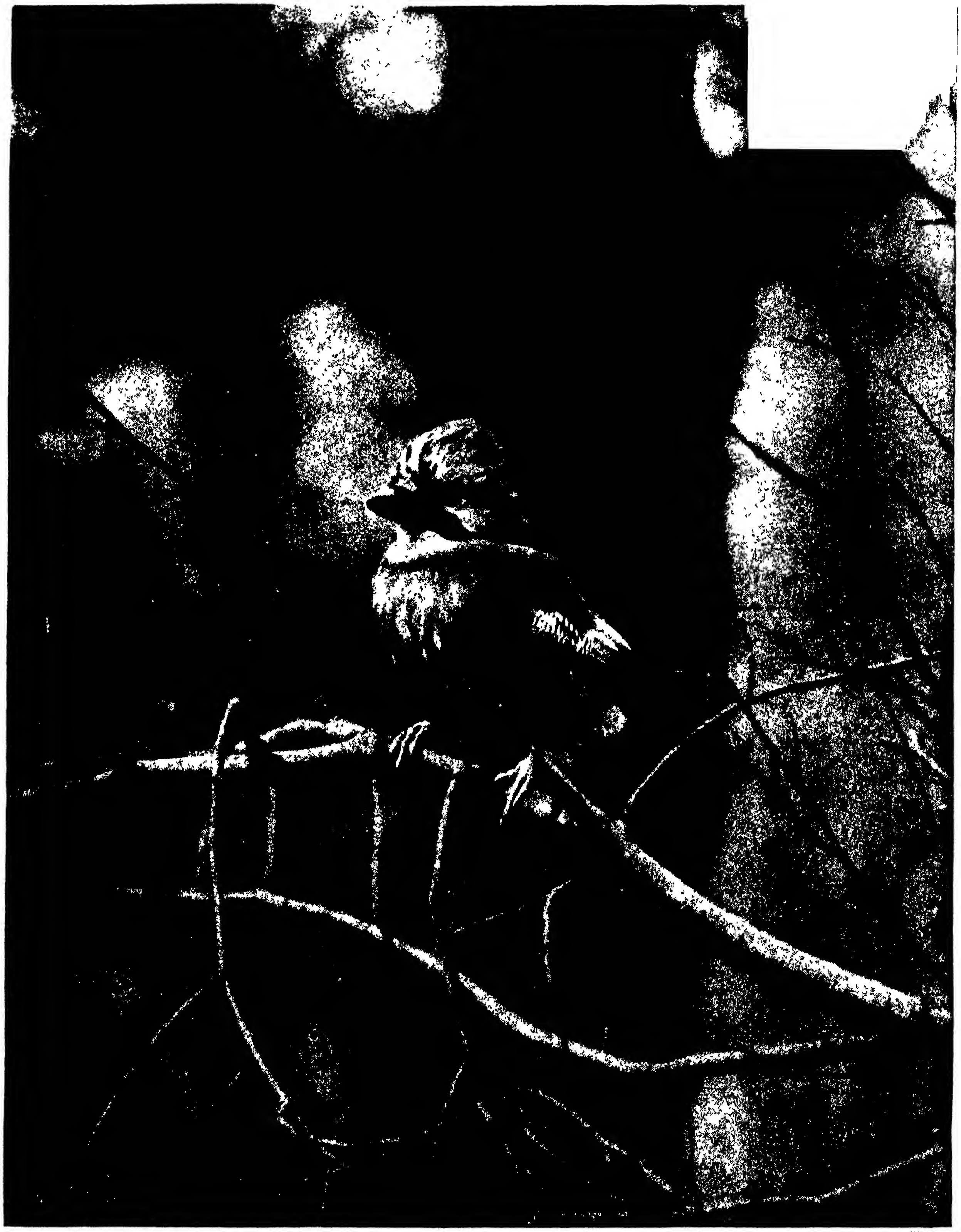
birds, almost every species, in the males at any rate, is thus arrayed in "purple and fine linen." I say almost every species advisedly, for, as is the case of the humming birds, there are some which are clad in "hodden grey," both male and female: as are the females of many of the most empurpled species. It is to these simple types that we must turn in searching for a clue to the evolution of the splendours. But that is another story.

Before leaving the birds it will be helpful to turn for a moment to species like the kingfishers, which present a striking array of beautiful forms, and some are superbly coloured. The common British kingfisher is an example, and here both male, female, and young wear a resplendent dress.

THE coloration changes with the incidence of the light, passing from green to blue as the body turns first with the beak then with the tail towards the eye. But there is no "metallic" effect. Such colours belong to the group known as "objective" or "structural colours"; that is to say they are produced by the combination of a certain pigment with a superimposed, and very specially modified, but quite colourless surface.

Finally, be it noted, the variety of colours which may be borne on one and the same bird is often striking. Take the beautiful grass-finch, for example, which displays blue, yellow, green and red. No single flowering plant displays such a wealth of colour as this.

The gorgeous metallic-blue butterfly of the South American genus Morpho, with wings six inches across, one of the most beautiful of all insects, owes its superbly shimmering magnificence to the fact that every scale is engraved with fine, closely set, parallel lines or ridges. Under the microscope these scales, properly illuminated, are exquisitely beautiful objects. And the same is true of parts of the elytra, or wing cases of many beetles, especially, for example, of the wonderfully coloured diamond beetle of South America (*Curculio imperialis*). When seen under a low power this shows like clusters of jewels flashing against a dark velvet ground. The beautiful golden iridescence of the beetle Cassida, and its allies, is due to a film of



Peter Webster

JAY WHICH SOMETIMES SUFFERS FOR ITS BRIGHT COLOURS

The delicate art of tying artificial flies for fishing requires numerous kinds of feathers and the brilliant metallic blue feathers in the wings of the jay cause it to be hunted and slain to provide the angler with lures sufficiently bright to imitate the sheen upon certain insects that fish like. But it is not only the jay's wings which are brightly coloured. The crest feathers are white and tipped with black, and the nape of the neck and the ear coverts a rich, ruddy brown. A fine sight this bird makes, flashing in the patches of sunlight as it flies between the branches.

EXPANDING NECK FEATHERS OF THE AMHERST PHEASANT

An exquisitely tinted frill of feathers clothes the neck of the male Amherst pheasant. When the mating season comes round this frill is brought into play for the benefit of the female. The bird stands sideways to his intended mate and twists the frill round and up so that the head is almost hidden by a fan of gorgeous plumes. Through this the bird watches the effect of all this beauty on the female who, as a matter of fact, usually seems quite unmoved by even such magnificence.

H. Pastin

J. J. Ward

GIANT BEETLES FROM AFRICA

Tropical Africa colours many of her insects as gorgeously as her birds, and here we have some beetles, that in the lower photograph from Central and those in the upper illustration—goliath beetles—from West Africa. Some of these creatures measure about six inches from leg-tip to leg-tip

moisture beneath the surface of the elytra; and hence it is that dried specimens which have lost their colour can be restored by soaking in water, provided that the drying has not been too prolonged.

So far this discussion has been confined to a fixed and definite coloration, which can in no way be changed by the wearer save in so far as, in moving and turning about, it takes up a new position in regard to the incidence of light. For the source of this coloration is embedded in hardened tissues like feathers; or scales, as in the case of butterflies. When, however, the pigments are, instead, deposited in the naked skin, matters assume a very different aspect, for they are now more or less directly under the control of the nervous and muscular systems.

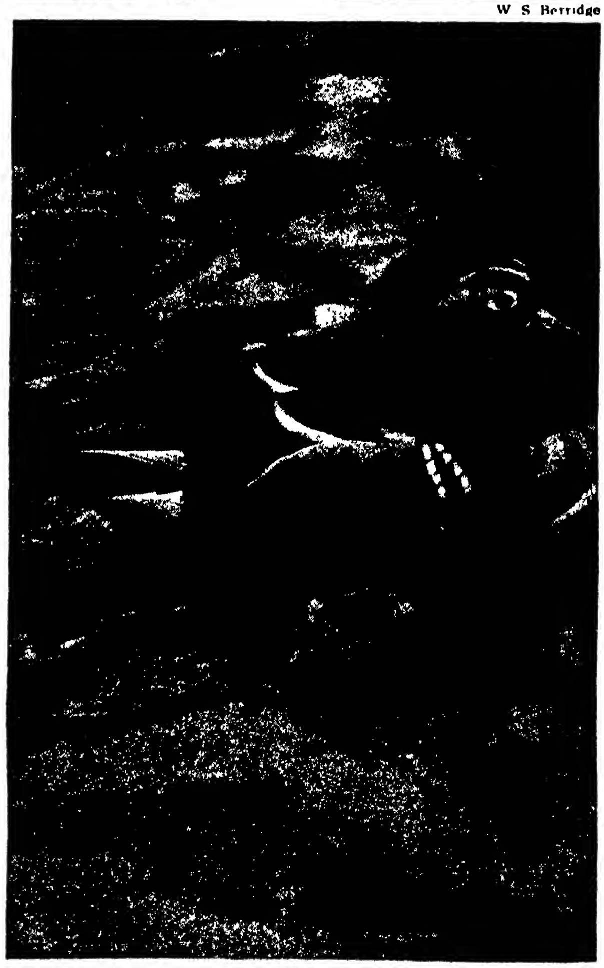
The foundation of this coloration is made up of various kinds of "chromatophores," that is to say, of little "blobs" of colour contained within a delicate sheath or pellicle, having a radiate form, like, say, a starfish, their arms interlocking much as one interlocks one's fingers in clasping the hands. To the end of each finger muscular fibres are attached, and when these shorten, under the appropriate stimulus of light, the sheath flattens and spreads out the contained pigment. The shortening process is carried out by the stimulus of the nerves, and as these are

W S. Berridge

TREE FROG, CARDINAL AND GORGEOUS IMPEYAN PHEASANT

Frogs seem to favour bright colours and about the most brilliant is the golden tree frog (bottom). South America produces a brilliantly coloured bird, the red-crested cardinal (top left) whose name suggests the splendour of its appearance. But the most brilliant of all the world's birds is the impeyan pheasant or monal (top right), which is found in the high forests of the Himalayas and other big Asiatic ranges. The male's crest is green, shot with purple and blue, and the rest of this creature of colour is a blend of copper-red, golden green, crimson and white.

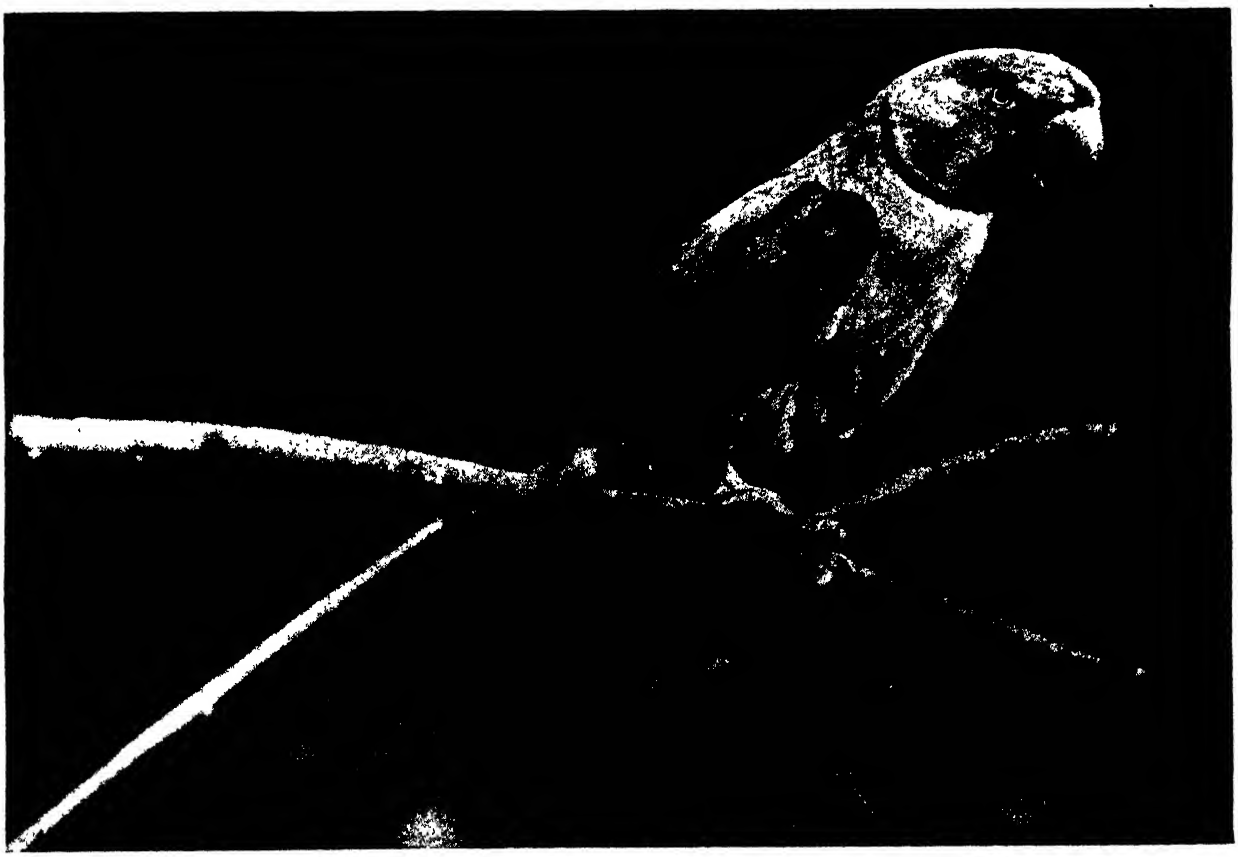
W S Berridge



D. Seth Smith

BIRD OF PARADISE, MANDARIN DUCK AND HUMMING BIRDS

With the birds of paradise we are faced with the most amazing splendour of wonderful colour, the whole effect being enhanced by the strongly metallic sheen on the feathers. Here (bottom left) is a greater bird of paradise engaged in "displaying" for its mate. The lower right-hand photograph shows one of the handsome mandarin ducks of Eastern Asia, a fine specimen of which is seen in the colour plate in this chapter. The upper photographs are of those fluttering jewels, the humming birds of the tropics



PALE-HEADED CAIQUE AND ALEXANDRINE PARRAKEET

The pale-headed caique (bottom) is a South American parrot of most brilliant feather, and belongs to a genus Caica or Deroptyrus. The colours are a gorgeous arrangement of green, white and orange. The upper photograph is of an Alexandrine parrakeet, whose colour scheme is made up of green and several different shades of very dark, almost black, feathers. This is native to Asia and parts of Africa, and the green plumage is almost invisible against the foliage of trees. But when against some contrasting background the brilliance of colour is very striking.

W. S. Berridge

BRILLIANT FISH OF WARM SEAS

Fish of the warmer seas tend to outdo all terrestrial creatures in the matter of colouring. This is not surprising when we consider the less transparent medium in which they live. Below is a long-spined chaetodon and above an "Emperor of Japan" fish

"tuned" to different intensities of light—each pigment responding to a different stimulus, sometimes all the dark, and sometimes all the light pigment may be dominant.

Besides the black and coloured "chromatophores" just referred to the skin of the Amphibia—the frogs, toads and newts—contains yet a third element. This is represented by certain bodies known as "iridocytes" composed of a reflecting substance.

The nature of the changes effected can best be grasped by following what happens to the animals coloured after this fashion. The late Dr. Hans Gadow tells how he received a number of green tree-frogs (*Hyla arborea*) packed in moss, from a friend. When unpacked they were of a dull greenish-grey. They were placed in a cage with freshly-cut branches of a lime tree; next morning the leaves had withered, and the frogs were nowhere to be seen! But after a little hunting they were found sitting on the dark brown branches. They had assumed a mottled brown coloration so like that of the boughs as to render them at first invisible! Later, placed with growing plants, they climbed up into the branches and matched the green leaves.

Now there is no green pigment in frogs. This colour is an "interference" colour, formed by the aid of the upper "iridocytes" just referred to. These have a yellow upper-surface and a white under-surface. The light passing through the yellow layer is reflected by the white, thus giving rise to the green appearance.

Our first conception of these comparatively rapid changes of colour was derived from the chameleon, which has long enjoyed fame on this account. At night its prevailing hue is creamy yellow, by day a greyish-green with darker specks and patches. But under the influence of excitement these tints are intensified, the pale-brown patches deepen to a full maroon, while the green is dotted with golden yellow.

Nowhere is this type of coloration seen to better advantage than in the fishes. A mackerel, newly hauled out of the sea into a boat, presents a play of iridescent colour exquisite beyond words.

E "flat-fishes"—soles, plaice, turbot, and so on—have formed the subject of some interesting experiments made by Mr. J. T. Cunningham. Normally, the upper surface of these fishes is some shade of brown, to match the sandy bottom where they rest, partly covered with the sand which they throw up by the movements of the fins, while the under-surface is white. By placing them in a tank with a glass bottom, and lighting this from beneath, Mr. Cunningham caused the white underside to become coloured like the upper. Some American naturalists went further than this in their experiments. A brill was placed in a tank floored with a pattern in black and white squares, like a draughtboard. This was all the fish had to rest on. As a consequence it speedily did its best to match this most difficult background, by developing patches of white all over the upper surface.

Chapter LXXVI

The Hidden World in the Soil

By Dr. B. A. Keen

Assistant Director of the Rothamsted Experimental Station

If a man were asked to think of the greatest contrast to our busy civilization he would almost certainly picture the countryside on a still summer afternoon, when all Nature appeared to be gently dozing in the warm sunlight. But he would be quite wrong, for this apparently immobile mask hides an amazingly active world—the hidden world in the soil.

Men of science are gradually unravelling some of its complications, not only because of the fascination it has for the scientific mind, but also because of the possibilities of improving agricultural and gardening methods that may be opened up by their discoveries.

We now know that the soil is not inert and lifeless. It is not just a mere collection of tiny broken fragments of rock (like the sand on the sea shore) but teems with myriad forms of life, vegetable and animal, in enormous numbers. We know also that without the activities of this population that inhabits the soil, the growth of crops, and indeed human life itself, would not be possible. Although we have as yet scarcely touched the fringe of the subject and its possibilities, enough has been found out to enable us to trace roughly the most important phases of the interlocked activities of the soil population.

This population includes many different forms of life. There are worms, insects of all kinds, and a bewildering variety of more lowly organized forms known as fungi, protozoa and bacteria. Some of these are helpful, some harmful, while others, as far as we can see, are neutral. Nothing like a complete census of the soil population has as yet been attempted, but even the incomplete figures are very large. Taking the larger forms of life, something like fourteen million separate individuals are found in the top nine inches of an acre of good soil, and most of these are concentrated in the top few inches.

The method used to obtain these figures is simple, although somewhat laborious. A block of soil of a known size is taken from the field, and placed on a coarse sieve, that stands on the top of a series of other sieves with finer meshes. The soil is broken up into smaller pieces and then a stream of water is directed on to it. All the fine soil particles are washed away, leaving on the sieves only the stones and coarse soil particles, together with insects and other members of the soil population. These can then be easily picked out, identified and counted. About half of them are insects, the remainder being worms, millipedes, centipedes, slugs, and so on.

But these numbers are completely eclipsed by those for the lower forms of life. The bacteria alone reach enormous figures. In a quantity of rich garden soil that could be easily held in an ordinary saltspoon there are no fewer than 5,000 millions of these organisms present, a number which is more than twice as great as the human population of the whole world. It seems almost incredible, for our first feeling is that there could not be room in the small quantity of soil for such an enormous number. But when the minute size of these organisms is taken into account the numbers are seen to be quite possible. The average diameter of a single organism is only about the ten-thousandth part of a centimetre, or the twenty-five-thousandth part of an inch. A simple calculation shows that the volume occupied by them is only one per cent. of the volume of the soil itself.

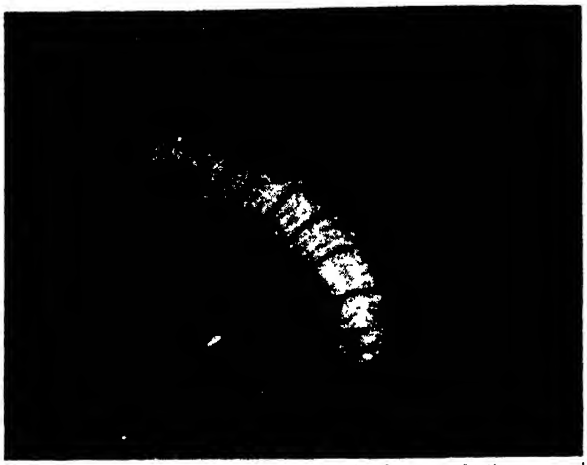
It is not easy, however, to visualise such small sizes and such excessive numbers as those just mentioned. We can get a better idea of the size of bacteria in relation to other members of the soil population if we imagine everything to be magnified to dimensions with which we are more familiar. If the bacteria were each as big as a pin's head (about $\frac{1}{16}$th of an inch in diameter) then on the same scale an earthworm only two inches long and $\frac{1}{12}$th of an inch thick would become equal to a Tube train, and he would travel through his burrow at about the same speed as the train does through its tunnel.

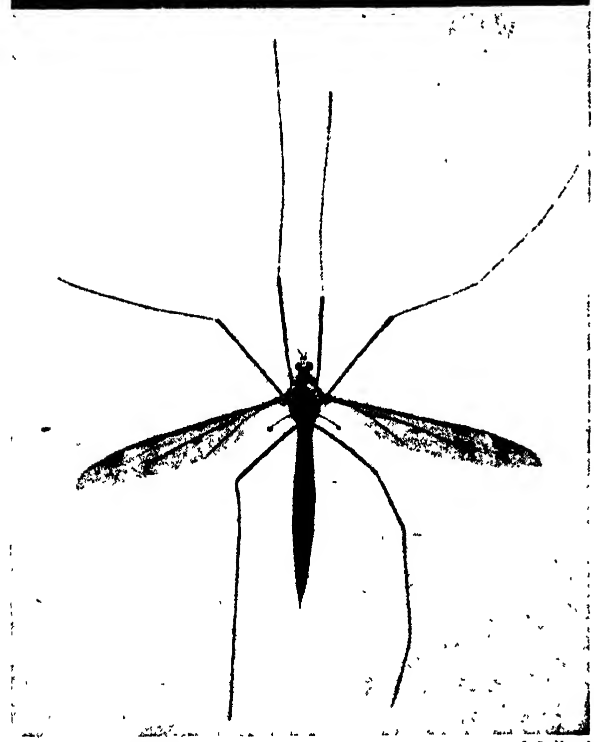
Although much more could be written about the soil population as a whole, the chief interest centres in what the main groups do and to what extent the growth of plants is dependent on, or hindered by, their activities.

Earthworms have been recognized as beneficial agents by all gardeners and farmers for a very long time. They

COCKCHAFER GRUB

For three years or longer the grub of the beetle called the cockchafer lives under the turf or the ploughed land, well hidden in the soil, feeding on roots and doing enormous damage to man's agriculture.





J. J Ward

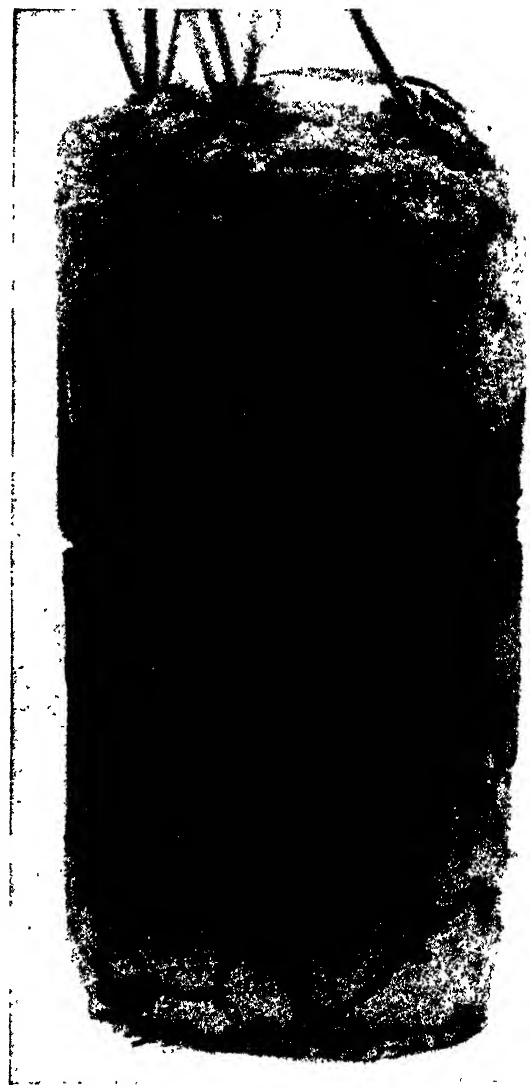
DESTRUCTIVE "LEATHER-JACKET"

The crane-fly is a dainty creature to see, but its progeny spend their larval stage in the soil where they are known to farmers as leather-jackets. Below we see the fly itself, and above the repulsive grub which does so much damage to growing crops.

indirectly benefit the plant by improving the condition of the soil itself. Charles Darwin believed that there were about 50,000 worms in an acre of rich garden soil, but recent experiments show that the number is more nearly a million, or one for every six square inches of the soil surface. Their burrows provide an easy means of entry for rain into the soil; their habit of pulling leaves and other vegetable material into the burrows provides the soil with vegetable mould and thus improves its fertility.

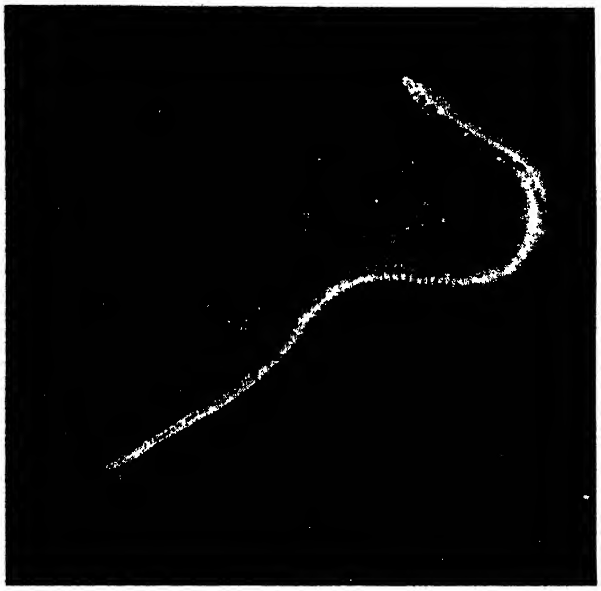
The "worm casts" on the surface of the soil consist of numerous small particles of soil that have been passed through the body of the worm in the process of feeding. These casts gradually break down under the alternations of rain and dry weather into a crumbly layer so that the soil surface is continuously being renewed by particles brought up from below. Darwin concluded that a layer of soil about $\frac{1}{30}$th of an inch thick was brought up each year by this means, so that any object originally on the surface would in the course of time become covered with soil. The thick layer of soil over the Roman pavements in this country has largely accumulated in this way.

Although earthworms are welcomed in the flower border or the kitchen garden, their presence in the soil of tennis courts, bowling and golf greens, is regarded with mixed feelings. It is difficult to maintain a detached philosophic attitude when a truly



WORM HOLES IN SOIL

Here is a section of soil cut from a field. It shows the number of tunnels made by worms in even a small area and illustrates how helpful these passages are for distributing rain. The photograph is from Russell's "Lessons on Soil," Cambridge University Press.



J. J. Ward

WONDERFUL EARTHWORM AND ITS LEAF-BURYING HABIT.

On the left we see an earthworm discovered by the camera in the open. The sun shining on its moist body makes it glitter like a piece of armoured hose. Worms continually aerate the soil by their burrows and renew the surface with their castings—the earth which has passed through their bodies. The right-hand photograph shows some of these castings and a dead oak leaf partially drawn into a worm's burrow. This habit of pulling dead leaves under ground for food provides leaf-mould to the soil.

struck ball is deflected by a worm cast. Certain chemical substances are known that are injurious to worms without seriously affecting the grass, and these are usually applied to the lawn in a water solution. Fortunately the copious fibrous roots of the grasses that ramify through the soil produce the same general action as the worm burrows and casts, so that the physical condition of the soil—and hence the growth of the grass itself—is not seriously affected by destroying the industrious worms.

THE next great group to consider is the insects. Some pass their whole life in the soil, while other species occupy it only during the pupal stage. All animals are dependent on plant life for their food; either they consume it directly, or, if they prey on other animals, indirectly. Usually there is a balance between the different groups, any tendency for one group to increase in numbers being checked by a corresponding increase in those groups that prey on the first group, until the equilibrium is re-established. Occasionally the check fails; conditions may become so especially favourable for the development of one form of insects that they increase greatly in numbers in spite of everything. If this particular species lives on vegetation it becomes a severe plant pest and may destroy large areas of crops, until it is brought under control, either by natural agencies or by the extensive use of suitable insecticides. The study of injurious soil insects and their habits is very important in order that their most vulnerable period may be known and chosen for attack.

One very unexpected result of the speeding-up of ocean transport, when fast steam vessels replaced the old windjammers, was the outbreak of new insect pests in some countries. The probable reason is that any such insects in the cargo are more able to survive the shorter voyage. They may in this manner obtain a footing in a country formerly free of them, in which their natural enemies may also be absent. In these conditions they will multiply unchecked, and soon become a serious menace. A most interesting recent example of this is the infestation by earwigs of parts of New Zealand, and the question at once arose, why should they multiply excessively there and not in England, when the general climatic and other conditions are so similar in the two countries? Investigation showed that in England earwigs are kept in check by a parasite that was absent in New Zealand. Numbers of this parasite were specially bred in England and shipped to New Zealand in the pupal stage to be liberated there and combat the pest.

AN earlier instance of a disturbance to the natural balance of insect and plant life was provided in Honolulu, where the extensive sugar-cane plantations were threatened with extinction by the great increase in numbers of certain leaf-hoppers, and stem-boring insects. All attempts to check these pests failed, until the natural parasites were especially introduced into the island, and in a very short time the trouble disappeared by the restoration of Nature's balance between the pests and the parasites.

On the whole, if we exclude the vital function of insects in pollination of plants, we may say that they are injurious rather than helpful to plant growth, so the gardener and farmer are more concerned to destroy than to preserve them. They provide in the soil a certain desirable stirring of the particles—comparable

J. J. Ward

BEETLES THAT ARE BUSY SCAVENGERS OF THE SOIL

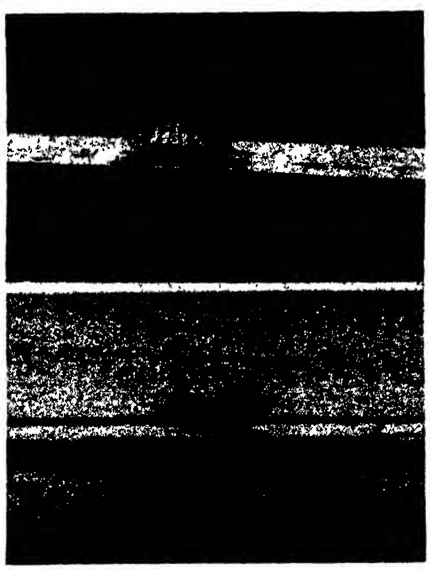
Often found in gardens is the violet ground-beetle (left) which is to be distinguished by the violet-coloured edge of its wing cases which are otherwise black. This beetle should not be touched, as it is liable to eject, for its defence, a foul-smelling liquid. The sexton beetles (centre) get their name from their habit of burying any dead bird or mouse they find for the purpose of feeding on it and laying their eggs in the body. The right-hand illustration is of a dor beetle among the grass. This is another scavenger of the soil.

to the action of worms—and, as a kind of poetic justice, their dead bodies become available in due course as plant food.

This leads us logically to a consideration of how animal and vegetable material become available for the nutrition of plants. It is here that the minute types of the soil population—the bacteria, protozoa and fungi—play a fundamental part, for they are actively concerned in the process of converting old plant residues into simple substances that are soluble in water, and therefore in a state to be taken up by the roots of the growing plant

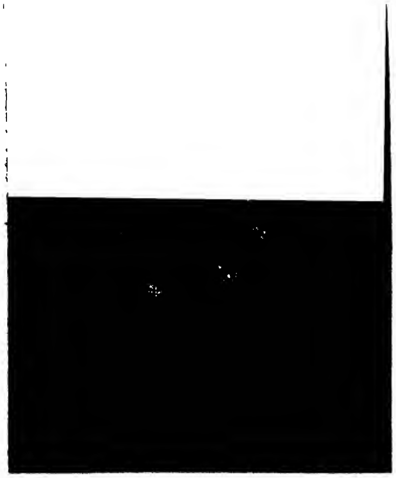
In the first place, however, we must get some idea of what these small organisms are, how they exist, and of the methods the scientist uses for studying them.

Bacteria really belong to the family of plants; they are not animals, but consist of single cells that have similar characteristics to the enormous number of cells of which the higher forms of plants are built up. When seen under a powerful microscope they look something like small transparent lumps of jelly, usually of a simple shape—round, oval, or squat rods. Some kinds have one or more waving, hair-like projections, by which they propel themselves through



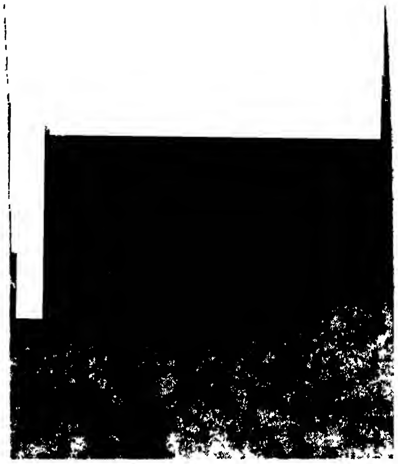
CENTIPEDE AND WOOD-LOUSE OF BRITISH SPECIES

Here (left) is a British centipede which is commonly found under stones. The number of legs in the centipede varies greatly, and a pair is attached to each segment of the body, the number of segments varying between fifteen and one hundred according to the species. The other photographs show a species of wood-louse (*Porcellio*) found in Britain, that on the right being magnified. This frequents damp places, but, unlike the pill wood-louse, cannot roll itself up into a ball, and is more or less helpless if it falls on its back as in the bottom centre photograph.



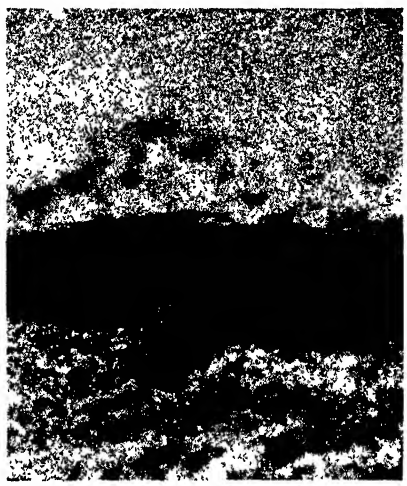
Eggs below ground

Larva resting in soil



Excavating for pupating chamber

Pupa in soil



Beetle just emerged

Packing wings beneath elytra

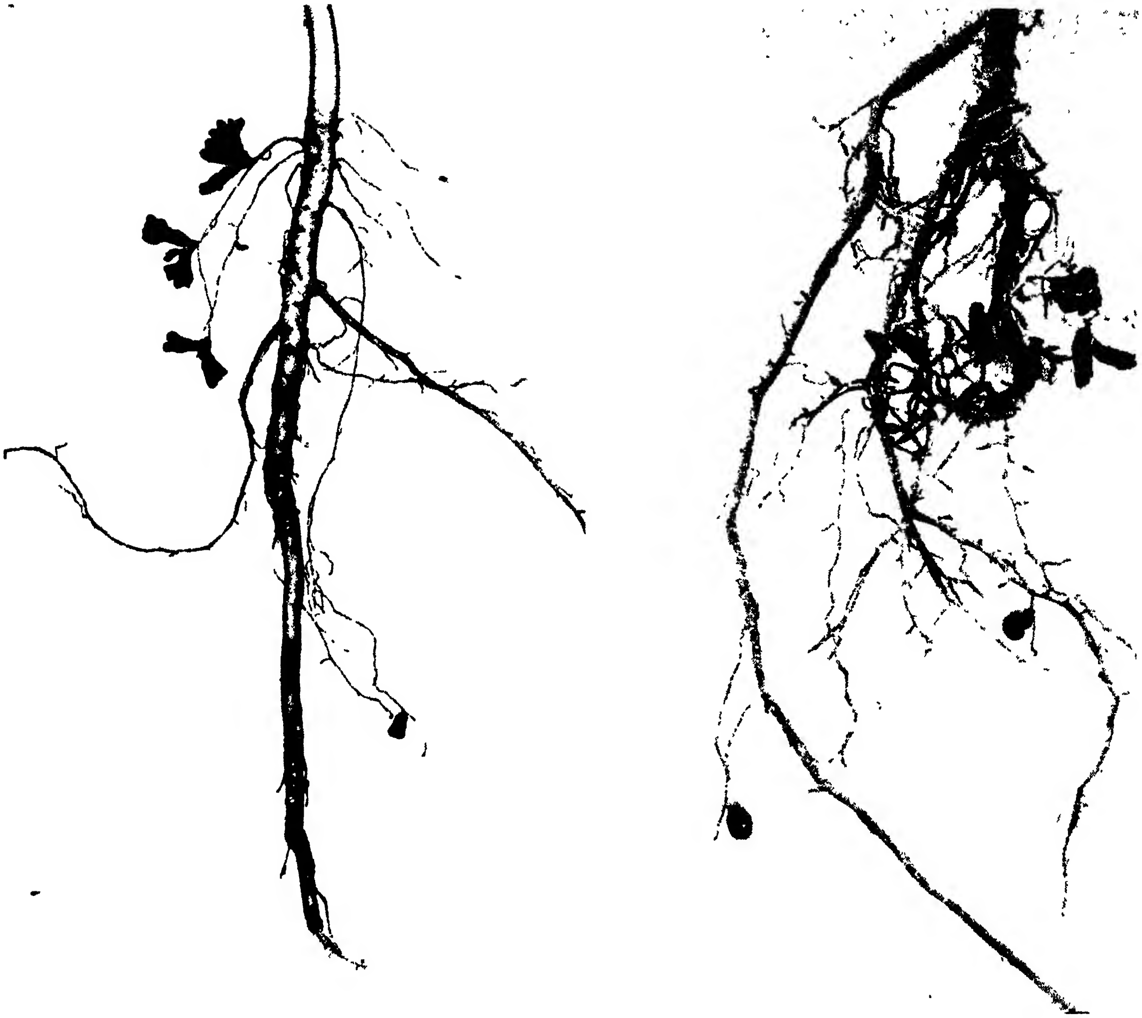
Walking with head down

Back view of beetle

In fighting attitude

LIFE-STORY OF THE DEVIL'S COACH-HORSE BEETLE

Familiar in most parts of Britain is the beetle called the devil's-coach horse which has the habit, when disturbed, of bringing the top of the abdomen up in a curve over its head as though it were a scorpion. This is only " bluff," however. It is usually found in the soil or under stones, although it flies well and it belongs to the family of the rove beetles. It is a scavenger of both animal and vegetable matter. The eggs are laid in the ground, where also pupation takes place. The above photographs, by J. J. Ward, show the beetle's life-story.



J. J. Ward

PLANT ROOTS WITH NODULES OCCUPIED BY BENEFICIAL BACTERIA

Enormous activity is for ever going on in the soil and the energy for this is derived, ultimately, from the sun. But animal life forms only a portion of the manifestations of this activity. Bacteria play the larger part. The bacteria belong to the plant family and consist of single cells which look like lumps of jelly Certain of them cause disease to animals, while others penetrate the fibrous roots of plants such as those seen above and, taking up nitrogen from the atmosphere, pass on beneficial compounds to the plant and so provide food for animals.

the soil water. They multiply by division, one unit splitting into two or more. These grow and in turn divide again The process of division may occur several times in 24 hours, so the increase in numbers may become very great in a short time, much greater than most people imagine.

There are two methods of counting soil bacteria. The older one has been in use for a long time, and most of our present knowledge of the different forms in the soil and their properties has been obtained by its aid The principle of the method is to distribute evenly by thorough shaking, a definite weight of soil in a much larger volume of water, and then to add a small measured quantity of this mixture to a gelatin (or other jelly) solution in which certain nutrient chemicals have been included. For convenience the gelatin is poured into flat glass dishes. A glass cover is placed over each dish and the dishes are put into a warm incubator. In a few days small spots appear on the gelatin. These are colonies of bacteria that have developed from the individual original ones in the liquid that was poured over the gelatin. The number of these colonies is counted, and, as we know what fraction of the original weight of soil is present in the gelatin, it is a matter of simple arithmetic to ascertain how many bacteria there were in the original soil. Many precautions have to be taken in this method. All vessels and dishes and materials have to be sterilised before use, to destroy any bacteria present, as otherwise these would develop into colonies on the gelatin and vitiate the results and the whole experiment.

THE method has many disadvantages. Unless the bacteria have all been separated from each other in shaking the soil with water, a cluster or colony,

J. J. Ward

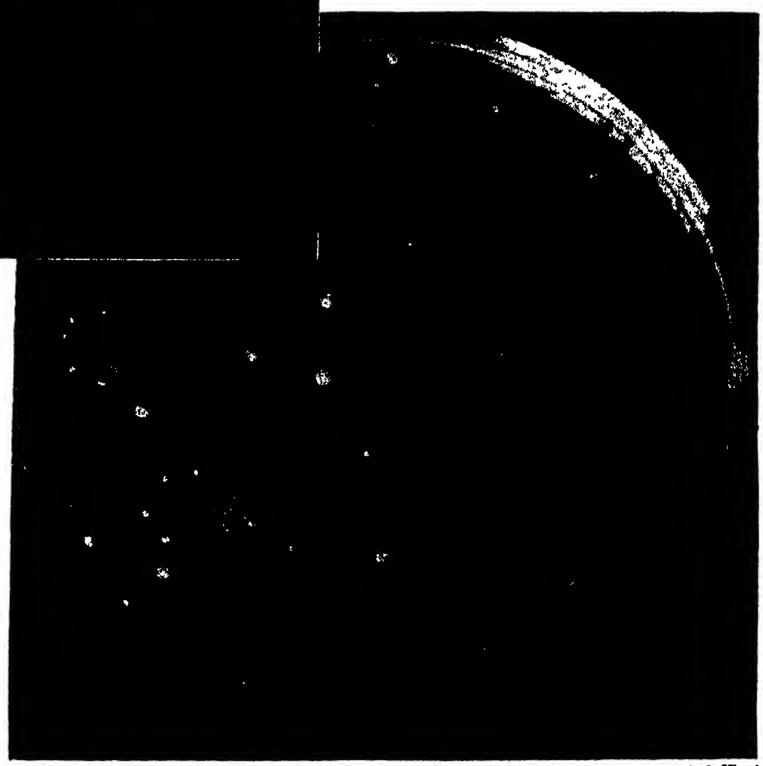
ACTION OF BENEFICIAL BACTERIA AND HARMFUL FUNGUS ON PLANTS USED AS ANIMAL FOODS

The left-hand photograph shows the root tubercle of a bean with nodules or knots formed by the action of bacteria. Incidentally the size of these minute organisms may be judged by the fact that if one of them were enlarged to the size of, say, a pin's head, an earth worm only two inches long would, if enlarged to the same scale, be about the size of a Tube train. The effect of the bacteria on the plant is explained in the opposite page. The right-hand photograph shows wart disease of potatoes due to a parasitic fungus

containing very many individuals, will count only as one on the gelatin plate. Again, not all of the numerous different kinds of bacteria will grow in any one nutrient solution, so that many species, known from other experiments to exist in abundance in the soil, will be missed entirely in this method of counting. Indeed, the newer method of counting, that depends on staining the bacteria with certain dyes to render them easily visible under the microscope where they can be directly counted, shows that the older method accounts for only one-hundredth of the total number in the soil. But it has one great advantage; the colonies are living and not killed, as in the staining method. A colony can therefore be picked out, transferred to another vessel and experimented on in the laboratory. Much of our knowledge of soil bacteria has been gained in this way.

In the soil the residues of plants and animals are broken down to simpler substances and eventually appear as a nitrate, which is taken up in water by growing plants and also by some organisms as a nutrient. If the soil is waterlogged so that air is deprived of entry certain species of bacteria attack any nitrate formed and reduce it to gaseous nitrogen that escapes into the air.

Other species of bacteria can use gaseous nitrogen directly and build it up into complex substances This process was a puzzle for a long time, and the solution was quite striking. It was found that a bacillus living in the soil was able to penetrate the delicate root hairs of plants such as peas, beans, and lucerne, or alfalfa, which belong to the class of plants known as Leguminosae. It multiplied into a colony inside the root, obtaining its food supply from the material of the plant sap. At the same time it possessed the remarkable power of taking up gaseous nitrogen from the atmosphere and building complex nitrogen compounds from it These were passed



J. J. Ward

BACTERIA COLONY AND ITS BENEFIT TO PLANTS

Nowadays the scientist and the agriculturist go hand in hand to work. The lower illustration shows us a glass slide on which a colony of soil bacteria has grown, while above are two lucerne plants, the one on the left in its natural state and the other, much larger, after it has benefited by bacterial inoculation.

on into the plant. Thus both plant and bacteria supplied the wants of each other. The nodules seen on the roots of peas and beans mark the positions of these beneficial bacterial parasites.

Now that the life-history of this bacillus is properly understood it has been found possible by suitable methods of bacterial inoculation either of the seed or the soil itself, to get satisfactory growth of leguminous plants in regions where they were formerly grown either with difficulty or not at all.

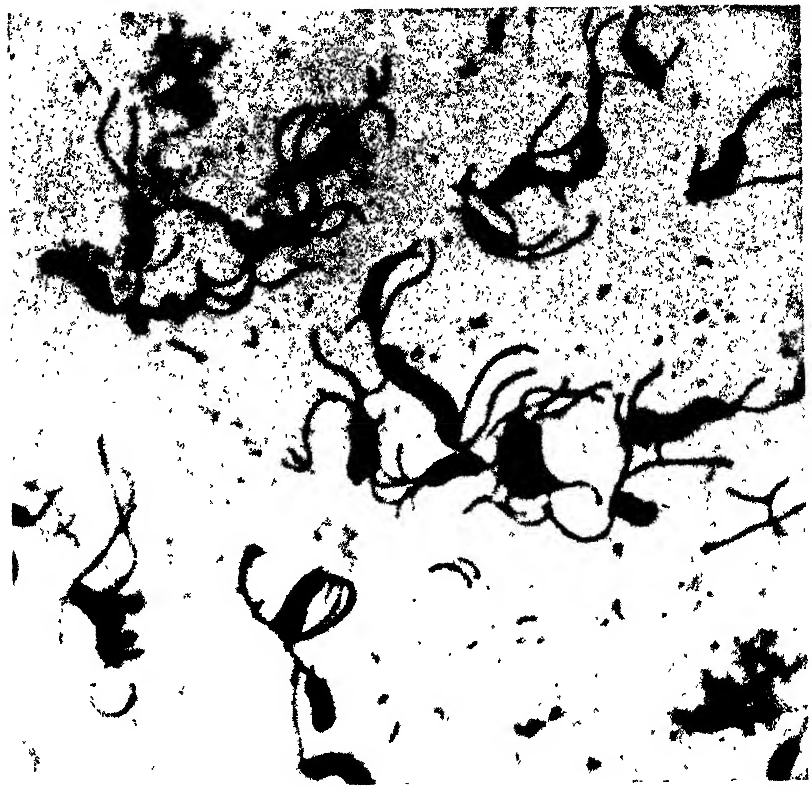
The action of bacteria in the soil may be summarised by saying that they take part in a great cyclic change in Nature. complex plant residues are broken down into simpler substances and these in turn are built up again by the next generation of plants and organisms into complex substances; these again in turn are broken down, and so on The energy necessary to keep this process in continuous motion comes ultimately from the sun.

Besides taking a prominent part in this cycle of events, bacterial life itself follows in general a cyclic periodicity. If conditions are favourable they multiply, but not indefinitely. Eventually there comes a point when the immediate food supply is exhausted, or when the waste products of their own growth exert a poisonous effect. They may then pass into a spore, or resting stage, and remain dormant until more favourable conditions occur. Drying of the soil is a frequent cause of spore formation, and the dust raised by winds contains many such spores that can develop when they fall on to a suitable medium. As is well known, epidemics of infectious diseases are quite often caused in this manner.

Although for convenience in description the general action and life-history of bacteria has been described

by itself, it does not constitute a distinct, walled-off part of the soil population. It is as closely dovetailed into, and affected by the other forms of soil life as is, for instance, the coal industry with the railways. It is especially bound up with the protozoa, for these organisms, although a very low form of life, are definitely to be classed as animals, and the majority feed on bacteria. The method of counting them is in its essentials similar to that used for bacteria, but it is possible to count separately those in the active living form and those that are dormant, or in the cystic stage. The numbers found are very much lower than is the case with bacteria, and they are, of course, much larger in size. The total number of all forms of protozoa in a saltspoon of soil rarely exceeds about a million.

A remarkable relationship has been discovered between some forms of protozoa and the bacterial members. When the latter decrease



J. J. Ward

MICRO-ORGANISMS WHICH HELP THE PLANTS

Below are some bacteria which take up nitrogen from the air and supply the vital commodity to plants as explained in page 838. Above we see another photograph of micro-organisms of the soil. Both these subjects are greatly enlarged.

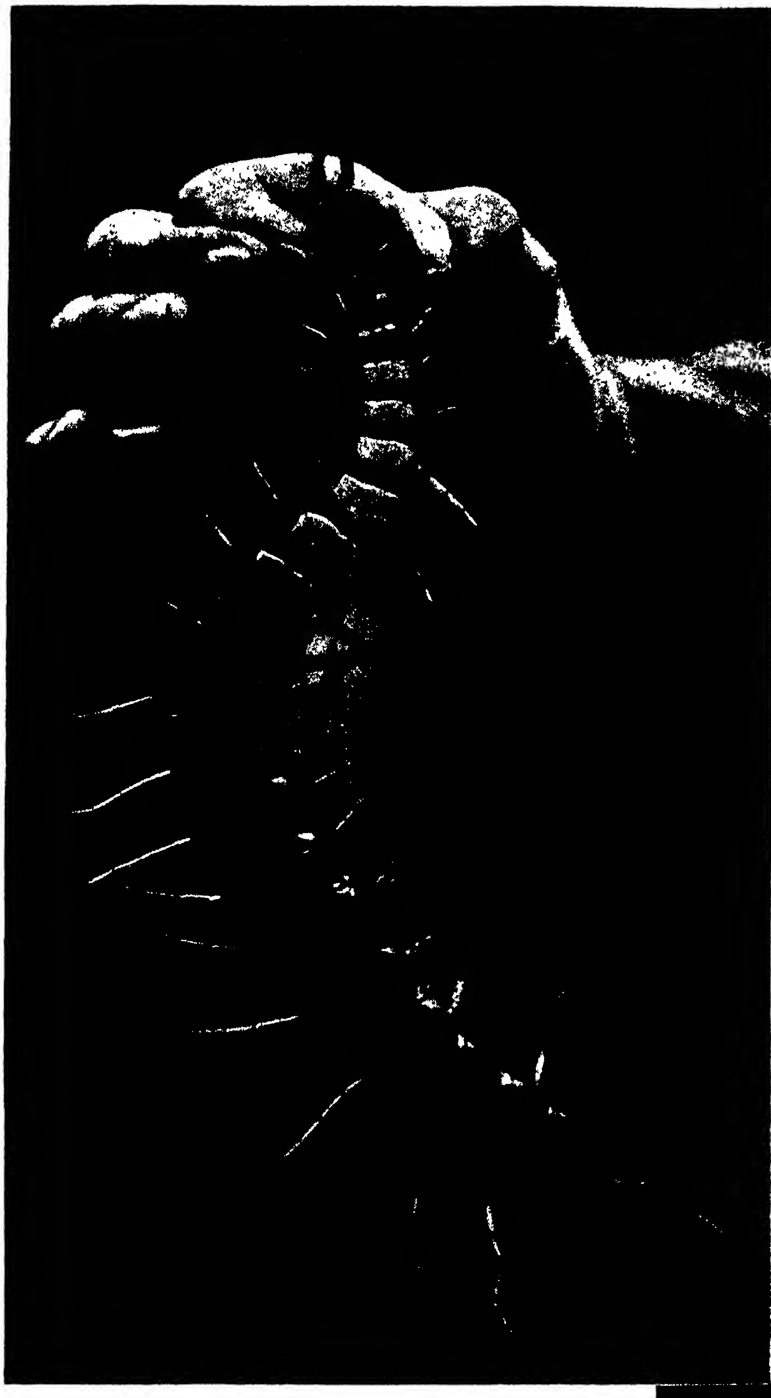
in numbers the former increase, and vice versa. The explanation of this alternating rhythm between these two groups of organisms is to be found in the fact that the protozoa feed on the soil bacteria.

Another important group of the soil population is the fungi. These are low forms of plants, and include a large number of different kinds. The larger forms, those that grow, for example, on decaying wood, and the mushrooms and toadstools, are familiar to everyone, but in addition there is a host of smaller kinds that can be found in the soil

Efforts to count these numbers by some reliable method have met with great difficulties, so at present no very definite idea can be given. The number seems, however, to be at least as great as that for protozoa.

Studies of their share in the activities of the soil population show that fungi are also concerned in the cyclic process of building up and degradation of the complex compounds, to which reference has already been made. Undoubtedly, the main interest and importance of fungi lies in the numerous plant diseases for which they are responsible, against which the farmer and gardener wage constant warfare. The great trouble is, to put it crudely, that the fungi are up to all kinds of tricks. A species that has lived a useful existence in the soil may, for some obscure reason, become parasitic on plants of economic importance, or again, one that has been the cause of a relatively minor plant disease in a small area may assume a virulent phase over a wide tract of country. Conversely, cases are known where serious plant diseases due to parasitic fungi have, for a time at all events, practically disappeared. This power of adaptability of fungi makes the task of the investigator very difficult indeed, and our present knowledge is not yet as extensive as in the case of bacteria or protozoa.

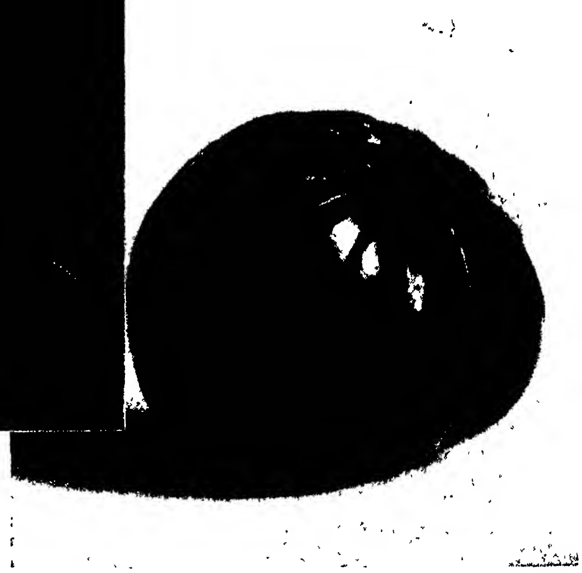
It is interesting to speculate how far the manifold activities of the whole soil population can be controlled by man. Is it possible to exercise a directive influence over their actions comparable to that already achieved both for yield and quality of crops



by using artificial fertilisers? Up to the present only the crudest measures of control have been achieved, and yet they have had immediate applications of practical importance. The inoculation of leguminous plants has already been mentioned, and this has been successfully used by farmers, particularly for lucerne, an important fodder crop.

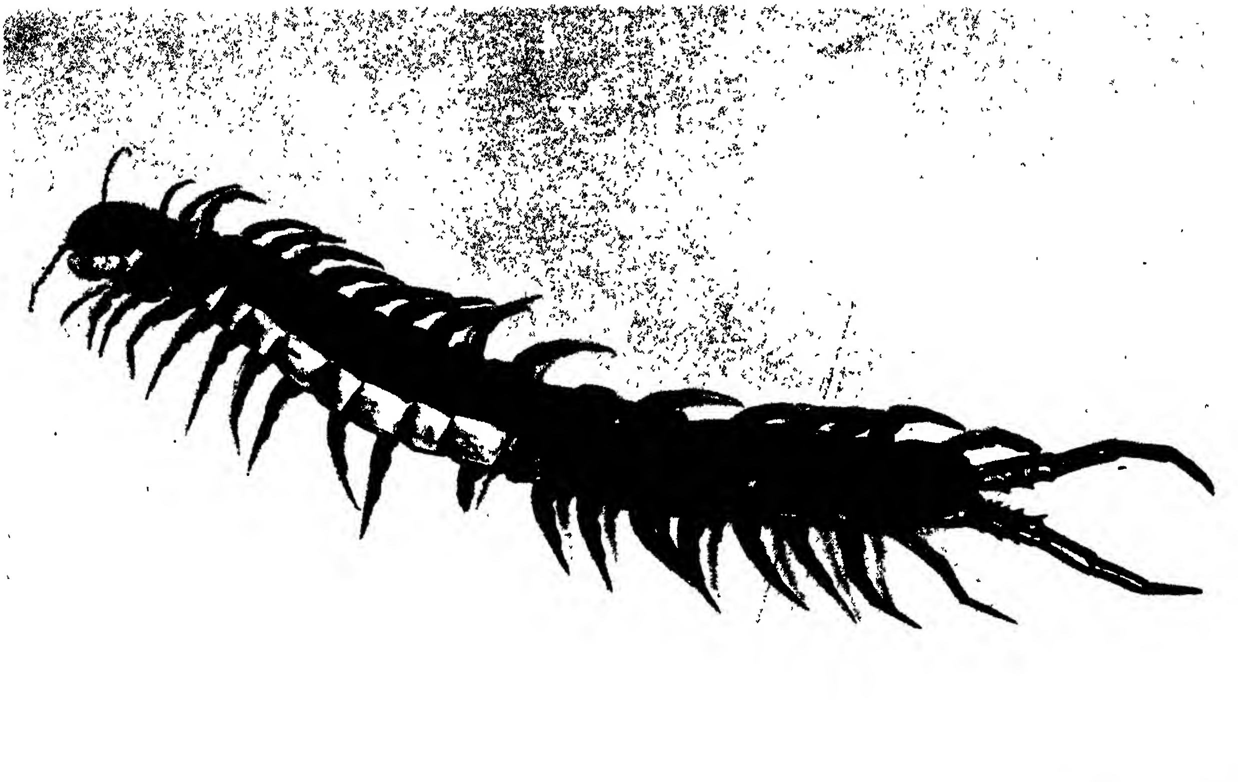
Another discovery of great economic value was the method of curing "sickness" in the rich soils used for growing tomatoes and cucumbers in glasshouses, an industry of considerable importance near large towns. It was found that the extensive growth of plant pests of all kinds in the soil could be checked by a preliminary gentle sterilisation of the soil by heat or suitable chemicals. The pests were killed, but not all of the bacteria, and hence the latter were able to multiply unchecked and produce plant food in abundance from the rich stores of organic material in the soil.

A third application arose from studies of the organisms causing decomposition of straw and other litter used as the basis of farmyard and stable manure. When their action was understood it was found possible to rot down this vegetable matter directly. The process has found practical application in two directions. The waste vegetable litter, grass clippings, leaves, etc., in the garden can now be turned into an organic manure. The second direction is of especial interest to parts of the British Empire overseas, where there is much waste vegetable material, such as the straw of the wheat crop, or the crushed stalks of sugar-cane. This material can now be rotted down and returned to the soil as valuable organic manure.

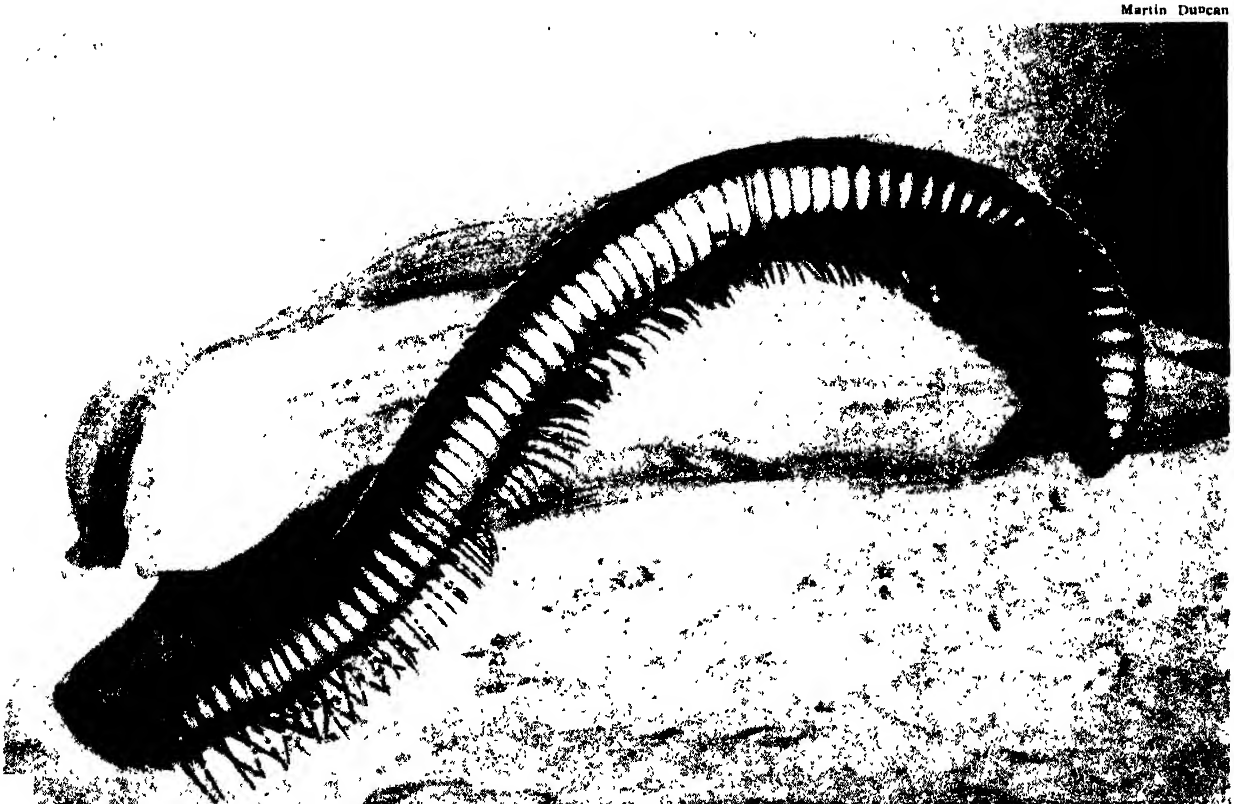


MILLIPEDE AND CENTIPEDE

Both the names millipede and centipede, meaning a thousand and a hundred-footed, are of course only arbitrary. Below we see one of the former, rolled up into a protective ball, while above is a giant centipede. The tropical kinds are deadly poisonous.



Martin Duncan



W. S. Berridge

GIANT MILLIPEDE AND A CENTIPEDE FROM TRINIDAD

The millipede is a sluggish creature moving about always on the ground and keeping out of bright light wherever possible. For defence millipedes are equipped with a number of so-called stink glands, which excrete a foul-smelling liquid to discourage attackers. The giant centipedes of the tropics, however (top), have the first pair of legs modified and extended forward to form poison glands They are deadly creatures, these big centipedes, and deservedly dreaded in the hot countries where they live.

R.N.A.

BEAR LOOKS FOR A NEW POINT OF VIEW IN YELLOWSTONE PARK

Bears have a name for inquisitiveness as well in the wild as in captivity. This photograph shows one in the great Yellowstone National Park, U.S.A., which has climbed a tree to see if there is anything of interest up there and to view the landscape. The camera has caught him in rather a remarkable posture. Curiosity suggests intelligence and, indeed, the bear is one of the most clever of the larger animals. One reason for this, or perhaps a result of this, is the fact that it is an omnivorous feeder and always willing to try some new dish.

Chapter LXXVII

The Curiosity of Animals

By Frances Pitt

Author of "Wild Creatures of Garden and Hedgerow"

We are told that "curiosity killed the cat,' but I doubt it, for it takes more than curiosity to kill a cat! Nevertheless it has killed many a bird and beast, from the inquisitive stoat, that must have a second look at anything strange, to the cunning inquiring jackdaw that must peer into every nook and corner crack and crevice. Yes, curiosity is a great factor among animals, whether wild or domestic, and the more intelligent they are the more inquisitive they become about anything that is strange or unusual.

I was once watching bird life at the edge of a wood, a tit clan busy in the trees overhead tumbling like fairy acrobats at the extremities of the twigs, thrushes and blackbirds hopping to and fro, and a handsome jay preening its beautiful plumage against the dark foliage of a yew tree, when on the ground beneath the tree a slight movement caught my eye Something had stirred. I gazed at the spot and the "something" took shape and form, and became a stoat. It was a small female stoat, and she was staring in my direction, her little sharp face and pricked ears betokening keen interest in the strange object. I kept perfectly still, and she came into the open, leaving the hole which had given her shelter, so that I could note her slender elegant form and dainty cream chest. She sat up, in a begging attitude, her furry forepaws folded together, and gazed at me more earnestly than before.

F. R. P. Stringer

THE SOW WONDERS WHO

This remarkable and most entertaining photograph has caught a sow, kept in an outhouse, just as she leant over the half-door to see who it was that passed and if there was any prospect of food. The ears, the whole attitude in fact indicate a mild inquisitiveness rather than mere vulgar curiosity.

Did I make an inadvertent movement? I do not know. All I can say is that she suddenly bolted, turning like the flick of a whip lash, and vanished into her hole. Had she gone for good? Not a bit of it: within a moment or two she was peeping out again. The insatiable curiosity of the stoat tribe was compelling her to have another look. Alas! that curiosity is often fatal, for the watchful gamekeeper knows only too well that a stoat usually comes for a second look, so if he sees one, and it disappears, he has but to wait for it to reappear, when the little hunter of the woodlands will probably be quieted for ever.

The female stoat I was watching had a full allowance of inquisitiveness; out she peeped, dodged back, and then, when I made a little squealing noise, like a stricken rabbit, sprang forth into the open. She could not make me out, she was suspicious, and her suspicions deepened. She gave a hiss, flicked her dark-tipped tail, and vanished yet again, this time quite for good.

I have seen a weasel, it was on a wind-swept fjeld-side in Norway behave just the same. It had been hunting lemmings in and out around some boulders, but when it saw me it ceased its pursuit to have a better look at the intruder. Out it hopped, sat up, stared, dodged down a hole,

TIGER CAUTIOUSLY CURIOUS

In this case the weather was very cold and the tiger, an animal coming as it does from a hot climate was wondering whether the temperature was bearable outside or not. The photograph was taken at the London Zoological Society's Gardens and gives us a splendid and typical tiger attitude.

and came out again, quite half a dozen times before it went on with its business.

Now the beautiful pine marten, a relative of the weasels, which in appearance combines their lithe grace with the attractiveness of a cat, is also desperately inquisitive. I had a tame one once, known as "The Mart," the most lovely and confiding of pets, and any thing strange had to be investigated at once. She was not happy until she knew all about it, whether it was a new ball to play with, or merely that I had got a new coat. The latter must be examined, especially its pockets, but she was not, after all, quite so inquiring as my two otters.

The otter also belongs to the weasel tribe, and in it the inquisitiveness of the family seems to reach its climax, but this curiosity is tempered with a wise discretion. My two otters, Thomas Romeo and Madame Moses, are of the most inquiring turn of mind, yet deeply suspicious of anything strange. If the new thing is quite outside their experience they give it a wide berth until satisfied it is harmless, after which they paw it and nose it all over. This at times is embarrassing, especially when one is trying to take photographs of them, as both otters know all about cameras, yet are never tired of examining them afresh. Hence the difficulty, for one cannot get a good photograph of an animal that is poking a wet and muddy nose against the lens.

ONE of the most striking instances of this inquisitiveness was when the two otters were paying a visit to the house, and someone opened a door which was seldom used. They immediately ran to it, stood up on their hind legs and examined the hinge as high as they could reach, just as if they were trying to discover how, where and why, it had opened.

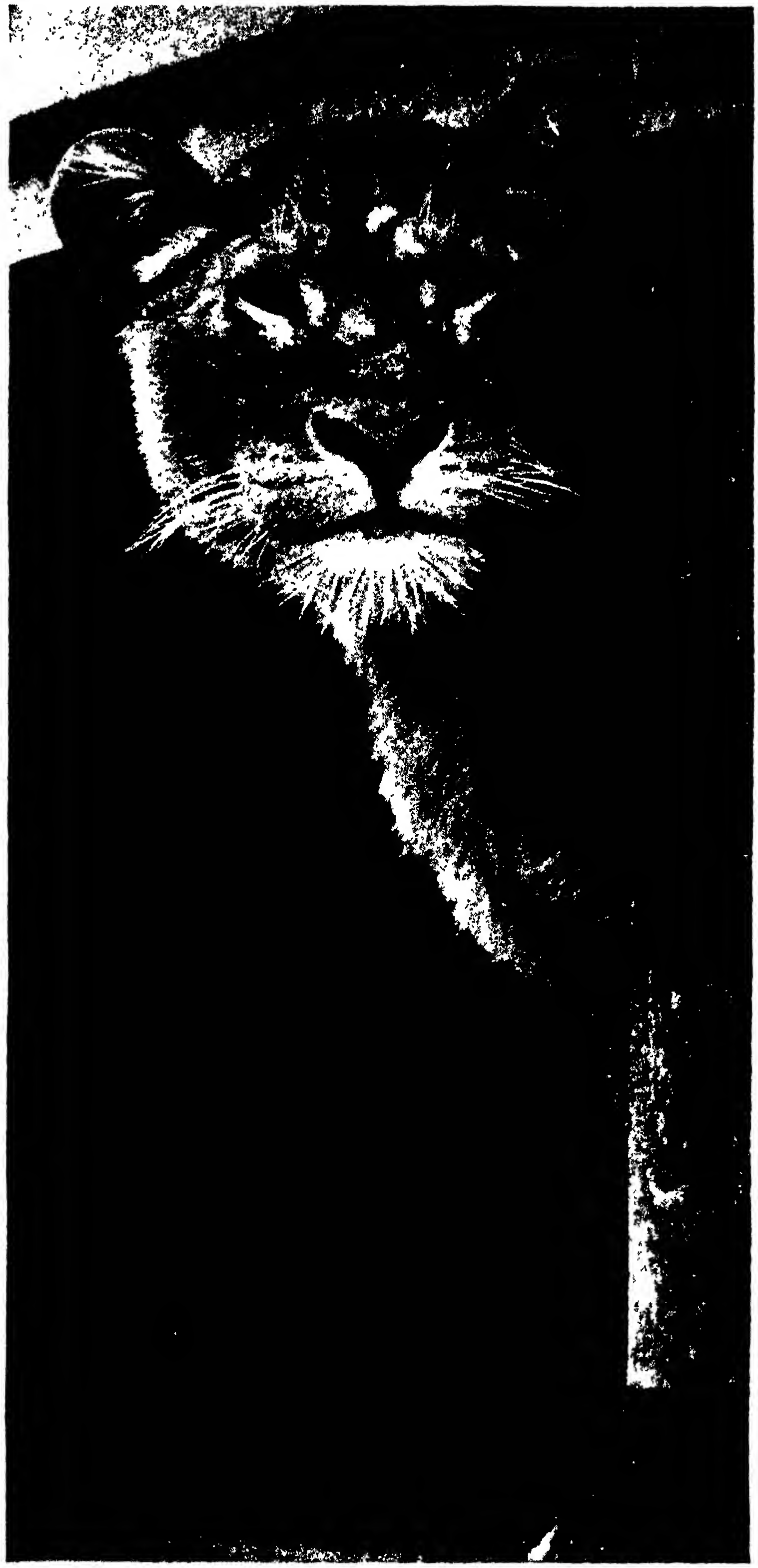
Now, curious as a cat undoubtedly is concerning anything unusual or out of the common, I have never seen one show such inquisitiveness as Tom and Madame Moses. Still, I do not wish to decry the curiosity of puss! I have just seen a workman prop a ladder against the stable wall, and he had hardly left it before a cat came by, paused, looked at the ladder, and turned aside for purpose of a closer inspection. Her inspection included climbing the ladder to its topmost rung, which was just like a cat! We could multiply

instances of cat curiosity by the hundred if not the thousand, for, after all, puss is liable to this little failing—if failing it be.

I consider inquisitiveness a sign of an active, inquiring mind. Without intelligence you cannot have curiosity. Yet the average dog, whose wits are certainly keen enough, does not betray anything approaching the curiosity of the cat, let alone an otter, but I think the reason is he is too preoccupied with his own affairs. The cat is, so to speak, a lady of leisure, with time on her hands, and able at any instant to turn aside for an interesting investigation. The dog's attitude to the world and life in general is rather that of the business man off to the city; he must get on with his job, even if it is only that of following his master, and is not lightly distracted or turned aside. Pure curiosity he leaves to the cat.

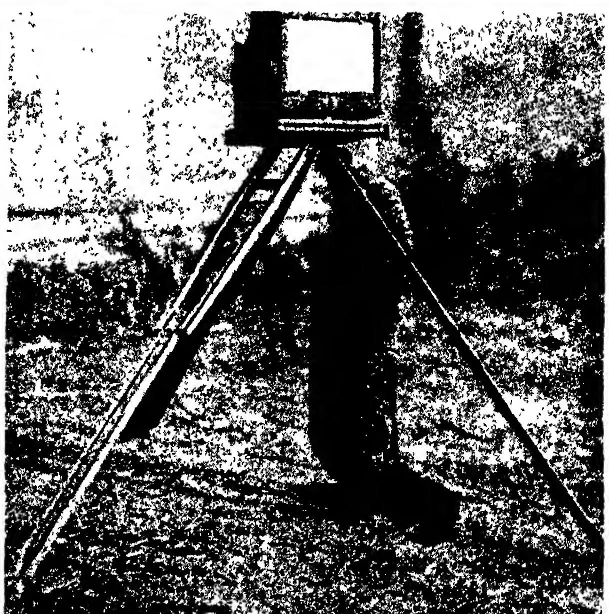
Birds have their share of it, too. One of the prettiest cases of inquisitiveness I have seen was when a party of blue tits investigated a waiting motor. The car had been left on the drive in front of my home, and the tits were in the habit of coming to feed upon a coconut hung by one of the windows. Looking out of the window I was amused to see some half dozen blue tits about the car. One little bird was sitting on the polished metal top of the radiator, pecking at it, as if aiming blows at its own reflection in the plate—was it really having a fight with the tit that looked out of the silvery surface? At any rate it appeared like it. But the rest of the party were simply investigating; two hopped to and fro across the top of the hood, peeping and peering into every fold of the material, another explored the running board, and a fourth peeped in at the window. More inquisitive little birds I have never seen.

The domestic fowl has its share of curiosity, as was well shown one morning when I took a tame fox through the farmyard. The numerous cocks and hens caught sight of the vixen at once. They began to chuckle and cackle in great excitement, but instead of running away they ran after her. The barn-yard ducks joined the throng to quack loudly at the sight of the strange little red dog, and follow the fox and me as I led her homeward. Far from showing any instinctive fear of their



INQUISITIVE BUT NOT OVER-BOLD

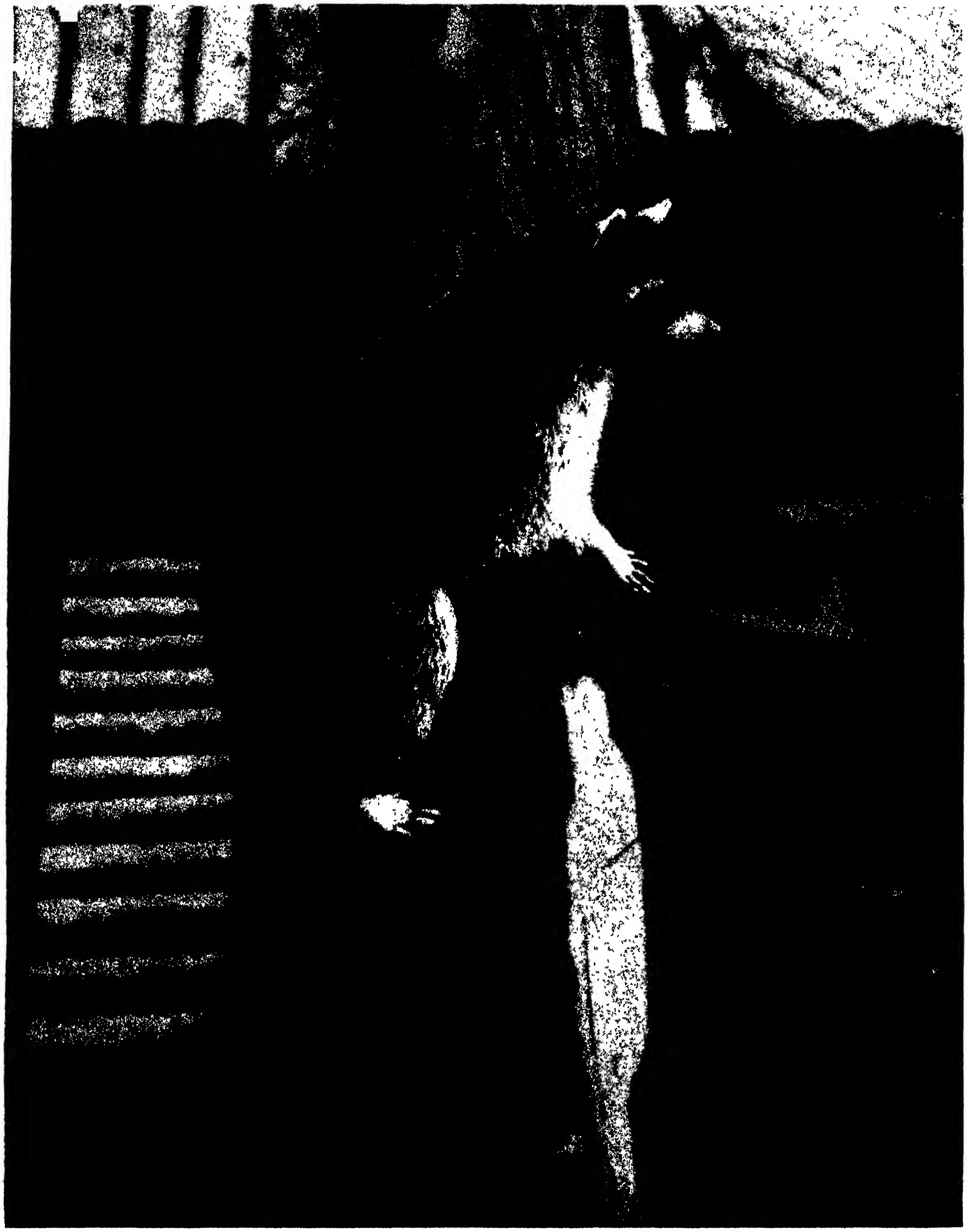
Here is a lioness of the London Zoo investigating conditions from the refuge of her indoor cage. The ability to know without being known is of vital importance to those who get their living in the wild from the hunting of wild things, and caution must mingle with curiosity as a condition of existence.



F. Pitt

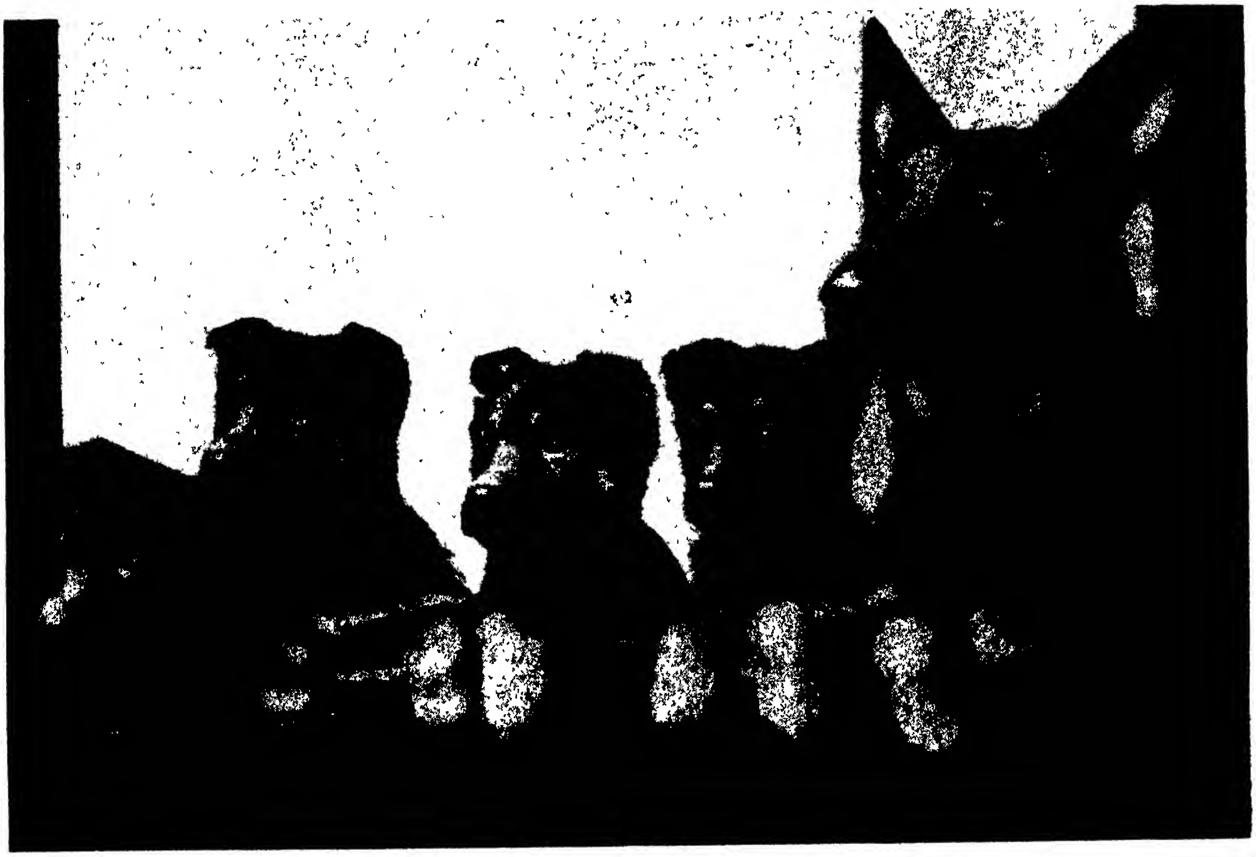
OTTER INVESTIGATES A CAMERA AND AN ANTELOPE A TIN OF FOOD

The lower photographs show a quaint instance of animal curiosity. Two otters, pets of the writer of this chapter, found this strange implement, a camera, one day. It was to be used for photographing one of them, but the otter was so interested in the tripod, the lens, and in fact, the whole instrument, that another camera was fetched and these happy "snapshots" obtained. Above are antelopes from a herd preserved in Wichita National Forest, Oklahoma, investigating food supplies.



RACOON, PROVIDER OF A POPULAR KIND OF FUR, ON THE LOOK OUT

Tree tops are the haunt of the racoon, which usually lives in a hole in the trunk high up from the ground and thus has home and look-out tower in one. Curiosity is, then, a special feature of the racoon's existence, for the animal is constantly watching from some lofty point of vantage for "something to turn up" whether it be danger or the chance of a meal. The racoon is a small relation of the bear, its body usually measuring about two feet in length and, by day, it usually keeps to its tree, descending at night to feed.



SEALYHAMS AND ALSATIANS INTERESTED IN PHOTOGRAPHY

Dogs are not, as a rule, so pervaded by the sense of curiosity as their chief companions in domesticity—cats. The dog is usually concerned with its master and the activities connected with him, and what is called a well-trained dog will subordinate the satisfying of its curiosity to the master's interest at the word of command. The cat, on the other hand is at its friendliest a guest, not a servant. Below are some Sealyhams and above an Alsatian and her pups "registering" (as they say in the cinema world) curiosity.

F. W. Bond

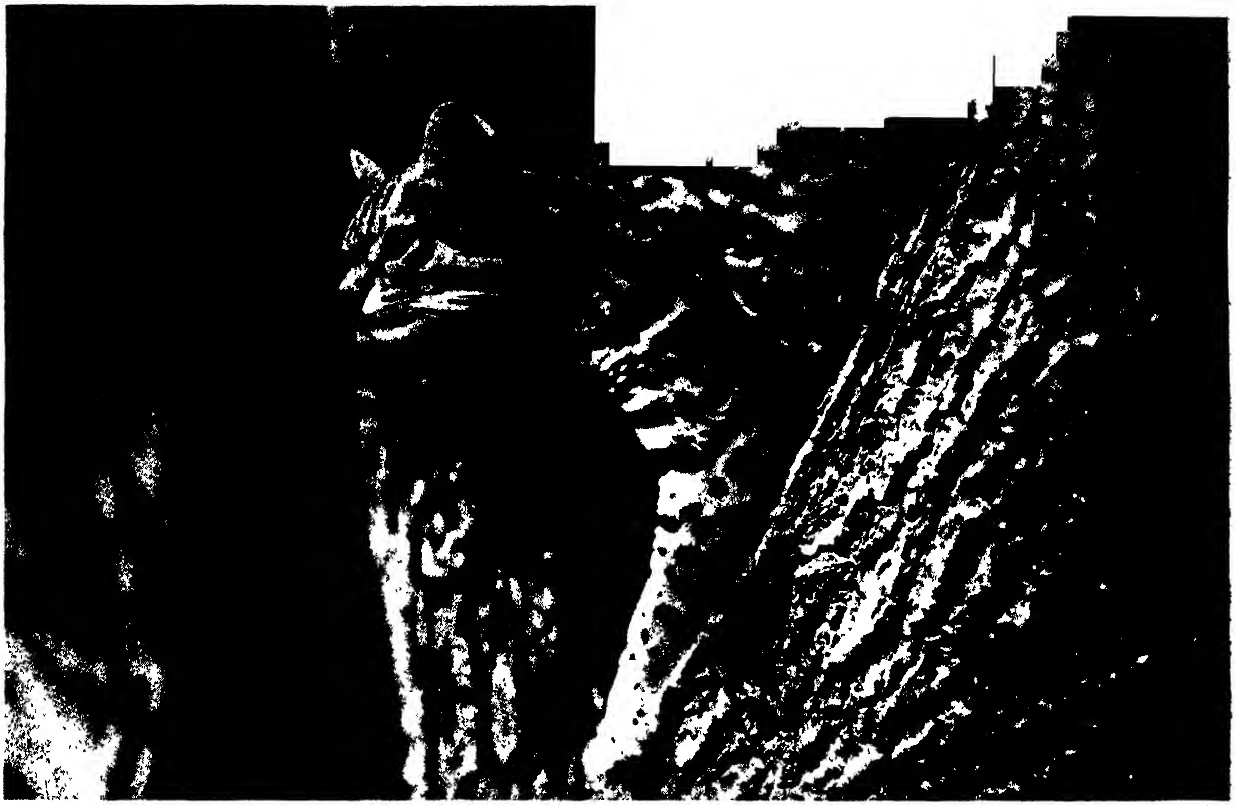
Mondiale

BEARS REACTING TO THE UNUSUAL IN TYPICAL BEAR FASHION

In that wonderful sanctuary for wild animal life, the great Yellowstone National Park, occupying some 3,350 square miles of territory in the states of Wyoming, Montana and Idaho, U.S.A., animal and man have begun to understand each other a little better and, consequently, some strange sights are sometimes witnessed there. In the lower photograph, for instance, we have a bear examining a, to him, strange new creature, the motor car. Above is a polar bear, which has just arrived at a Zoo, taking a long, wondering look at its new home

WILD LIFE IN THE TRANSVAAL ENCOUNTERS THE CAMERA

A camera, especially if it be standing upon a tripod, is such a curiosity-compelling object that few wild animals can resist it. Fear of the unknown and the itch to know something new—for there is, perhaps, a certain sameness even in the fulfilling of the law of "eat or be eaten"—struggle, each emotion with the other, until curiosity finally wins. Below is a giraffe daring to satisfy its inquisitiveness, and above, kudu at a waterhole where a photographer was lying in wait. Waterholes are favourite "pitches" for the wild animal photographer.



E.N.A.

Neville Kingston

OTTER AND THE FIERCE TIGRELLO, OR MEXICAN WILD CAT

Pausing as it swims, the otter (bottom) distracted by some sound or sight on the bank tilts up its head to observe. At all times the otter is, like the famous elephant's child in the "Just So Stories," filled with insatiable curiosity and when the animal is kept as a pet, this quality, which is developed a hundredfold by a domestic environment, affords endless diversion. The upper illustration gives us a glimpse of a tigrello, or Mexican wild cat, stationed in the fork of a tree and looking for the cause of the disturbance it has noticed.

MASS CURIOSITY AMONG THE MONKEYS

This photograph was taken at the Washington Park Zoo, and shows a great number of monkeys, the most inquisitive of all animals, climbing a tree after their leader, who suddenly conceived a desire to examine the prospect from the top.

ancient enemy the hens seemed filled with curiosity. The country folk have a legend to the effect that when a fox finds fowls roosting up in a tree, instead of being safely shut up in their fowl-pen, he gets them to come down and come within his reach by the following device. They say that he takes his brush in his mouth and spins round and round in a crazy dance, which so mesmerises the hens that they fly down into his jaws. This is, of course, simply "an old woman's tale," but it has a slight foundation of fact, namely, that fowls are so inquisitive that they are quite likely to fly down from their roosting-place to get a better look at a strange animal.

In the " days of old " the curiosity of the mallard was turned to good—or should one say evil ?—account. Certainly the result was bad from the ducks' point of view, however excellent from the standpoint of those who ate the mallard ! I am referring to the decoys which were then in common use in many parts of Europe, and of which one or two still survive in working order in Great Britain. The success of a decoy depends entirely on the inquisitiveness of the ducks that are to be decoyed.

Apropos of the fascination my pet fox had for the fowls,, she was equally attractive to the tame mallards. They would come ashore from the pool when she was at play in the garden, and follow her about to watch her antics. Sometimes the vixen made rushes at them, and I feared would catch one, but they did not seem to have any apprehension of danger, and, after scattering before her rush, soon waddled back to have another look.

However, it is not only mallard, but many other kinds of duck that are troubled by an inordinate curiosity. I have seen teal, widgeon and tufted ducks much excited at the sudden appearance of a cat, following it as it ran along the waterside as far as they could swim after it.

In the case of many wild animals, curiosity is neutralised by fear and caution. Though the strange thing is interesting it may be dangerous, and the impulse to have a look at it is overcome, or partially overcome, by the equally strong impulse to give it a suitably wide berth.

I have often noted this when trailing wild creatures in the snow, their tracks betraying how they have cautiously circled around anything new and strange, before venturing near enough to investigate it.

It is the same with domestic animals, such as cattle and horses. You will see in them the same conflict of emotions, though in their case curiosity nearly always wins, for they have not the same deep fund of timidity which makes the wild animal so nervous.

Once a bird or beast knows all about a thing, it loses interest in it. What is well known is dull and not worth troubling about, so the creature goes off to seek something new. Just as inquiry is the salt of existence for us, so it is for the lower animals. Curiosity is nearly as great a force among them as it is with human beings, and that is saying a great deal. Curiosity shows us mind at work, hence curiosity in the animal world means intelligence to the fore.

Chapter LXXVIII

The Marvel of the Paper-making Wasps

By John J. Ward

Author of "Some Nature Biographies"

It was a day in late autumn, and a lady called me into her garden to see a strange thing that was happening. A wasp had arranged a row of fat, white grubs on the gravel path, and at almost regular intervals was adding another to the line—an amazing incident, and one around which there hung a wonderful story.

Those white grubs in the natural order of things were destined to become wasps, and the worker wasp we now saw removing its charges from the nest, with its inborn instinct of straight rows of cells, was arranging these half-developed wasp grubs in proper cell order, side by side. Until that very hour that worker wasp had tenderly fed and nursed those same grubs, but now things had changed; it was ruthlessly dragging them from their cells and conveying them into the open to perish with cold, or to be devoured by an insectivorous bird.

Disaster had suddenly fallen upon a great wasp community of some sixty thousand inhabitants; order had given way to confusion, and only a few of the newly-emerged worker wasps imbued with the keen instinct of work, like our example on the gravel path, were keeping a cool head and trying to make the best of a dire calamity. The older workers had lost heart and rested dazed and confused amongst the cells, or around the outside of the nest.

The trouble began the night before, when the temperature suddenly lowered until by early morning it had reached a stage of frost—the death knell of the wasps. Notwithstanding that the wasps were all safely in the nest below ground, so sensitive were they to what had happened that all hopes for the future had vanished completely. Unlike the honey bees, they store no food in their combs, and there is no shelter for the winter in their frail home.

Later in the morning when the sun had broken through, the drowsy and half-paralysed wasps developed some amount of activity, but since there was now no hope of rearing the thousands of grubs in the cells, the wasp on the gravel path, and a few of her sisters proceeded to remove their charges from their cells to perish quickly in the open. "How merciful, rather than to let them die slowly," says the moralist, but there is no mercy involved in this action of the worker wasps. It is a last instinctive act for the welfare of the race; the individual may be sacrificed, but the race must be maintained. This last act of removal of the grubs is purely one of leaving the nest in a good sanitary condition in readiness for the emergence of the males and young queens on which depends the destiny of the next generation. Males and young queens will continue to emerge from the large closed cells in the combs after the workers that built those cells have perished.

The male wasps do not appear until late summer, and they await the advent of the young queens. They do not play any part in the building of the nest or rearing of the wasp grubs, and during the day leave the nest and sun themselves on the leaves of trees such as those of the sycamore, where they are fond of licking off the sugary substance known as "honey-dew," an exudation of the aphides. They are not provided with stings, and they can easily be caught by the hand if you are quite sure of your identification, their characteristic features being a long, slim body and longer feelers than those of the worker wasps.

When the young queens begin to emerge the waiting males immediately find their mates, for, unlike the honey bees, the mating not infrequently occurs just outside, or even on, the nest, and with individuals of their own great family. It is somewhat astonishing, too, how each of the couples in recrossing each other's tracks during their courtship seem to concentrate entirely on their selected partners.

After mating the male wasps die off, and each young queen at once seeks some warm quarter in a sheltered spot in the hollow of an old tree, or beneath a thatched roof or some similar situation, to hibernate for the winter. When, in late October, she has found her winter residence, she settles comfortably down, first gripping firmly with her mandibles some projecting particle of bark, or, in a roof, perhaps a protruding straw, and then folds her wings and tucks her legs close to her body. Suspended by her strong mandibles she sleeps away the winter months, awakening some day in early May. From this it follows that any wasp we may meet with between November and early May will be a queen wasp, and the potential mother of a new wasp community; hence the killing of that wasp means one wasps' nest less for the following summer. As that nest may contain from twenty to sixty thousand individuals it is obvious that the proper time to kill wasps is early in the year.

While the structure of the forsaken nest holds together it becomes the prey of slugs, snails, woodlice, spiders, earwigs, and other creatures, and that wonderful fabric so marvellously built by the many thousands of workers soon falls to ruin. Here, again, the wasp differs from the honey bee whose hive shelters the colony for the winter period; and although our sympathy may lean towards the wasps whose labours, at the very zenith of their success, were so suddenly doomed, yet we have but to imagine the consequences if it were not so. If the queen alone can become the mother of sixty thousand offspring from early May until she dies of old age in October, we can only wonder what would happen

M H Crawford

H. Bastin

TREE-WASP'S NESTS

As opposed to the ground-wasps, which make their nests underground, the tree wasps construct theirs in the open air. Below is a nest in the earlier stages of its building, and above one found in a packing case which provided a handy source of "wasp paper."

if the community recommenced in full strength in early spring; there would, indeed, be a plague upon the land, and wasps would reign supreme.

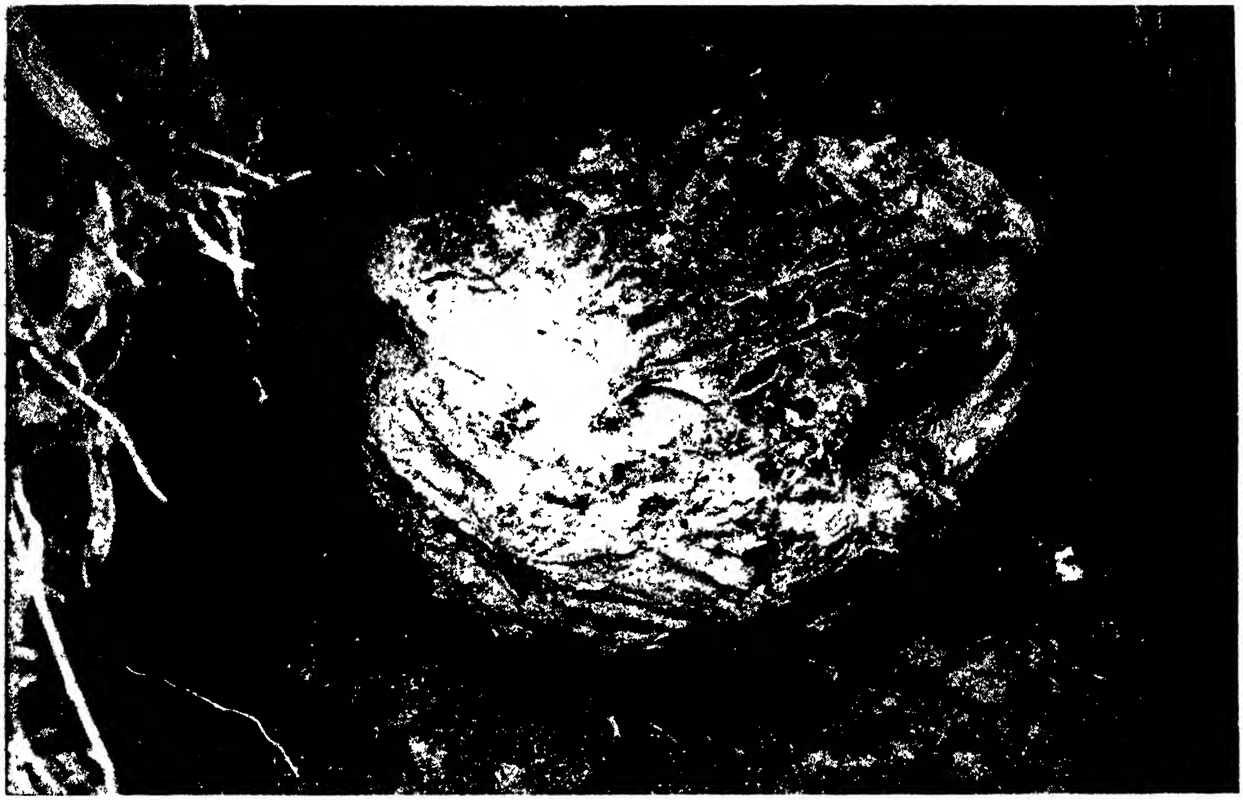
There are two kinds of social wasps, tree-wasps and ground-wasps. Both kinds construct their nests by much the same methods, but the former build their nests in the open air usually amongst the branches of some prickly shrub, such as a holly bush, or a hawthorn hedge, although one species shows a partiality for the branches of a fir tree; while the ground-wasps excavate the soil and build their nests in darkness underground, and occasion ally under a roof, or even in a hollow tree Hornets which are merely a large species of wasp, usually prefer the two last-mentioned sites. Whether it be tree-wasp, ground-wasp, or hornet, with each kind the building is commenced in the spring by the queen after her hibernation. There are three British species of tree-wasps, and, including the hornet, five ground-building species, although one of these, the Austrian wasp (*Vespa austriaca*), is apparently a sort of "cuckoo," or interloper, in the nest of the red wasp (*V. rufa*), and appears to be represented only by males and fully-developed females, the workers of the host wasp rearing its family.

The queens of the two common ground-wasps (*V. vulgaris* and *V. germanica*) commence to build at the beginning of May. After awakening from her winter sleep each queen pays considerable attention to her toilet (for she and all her kind are models of cleanliness), after which she tours the neighbourhood in search of a nesting site. Buzzing gaily, and full of the joy of life, her attention is largely given to the bottoms of hedgerows, projecting tree roots appearing particularly attractive. After many unsuccessful examinations she at last becomes interested in a disused mouse run, in and out of which she continually travels with obvious excitement. It is certain, too, that she has decided on that spot, for she is carrying out in her strong mandibles bits of nut shells, tiny twigs, little stones, and other odds and ends. She is tidying up the place to adapt it for her home.

After an hour or more of this occupation she comes outside and, alighting on the bank, she devotes several minutes to brushing her face, head, and body briskly by means of her bristly legs, finally drawing each of her feelers from base to tip through her folded forelegs. Then all is ready, and, taking to her wings, she circles several times around the entrance to the burrow, each circle getting wider until she is well up in the air, when she puts on speed and makes a definite course. During that circular tour round the site of her nesting quarters her mental faculties had made a comprehensive record of details that, on her return, will guide her again to the exact spot.

If we could follow her in her flight we should discover her alighting at some distant spot to investigate some wooden palings, or an old tree, and the chances are that the wooden fence would prove most attractive to her. Alighting upon it, she would proceed to scrape it with her strong mandibles. Splinter after splinter she would tear off, munching up each one, and mixing with it saliva secreted from special glands with which her tongue is provided, until her mouth was full of paper pulp. Then she would fly rapidly back to her building site, encircling its entrance with diminishing circles as she approached and then rush in with obvious delight. Perhaps at the end of the run there would be a space about the size of a hen's egg, and in that space she would commence to build a nest that by autumn would probably be as large as a four-pound loaf.

On a bit of exposed root in the roof of the chamber, which before leaving she had nicely cut and cleaned



with her mandibles, she now by means of those same useful tools spreads her mouthful of wood pulp, forming it in the shape of a flat disk—the foundation stone of the new wasp building Further visits to that same fence are then made by this industrious little creature. Each time she scrapes away as much wood as she can conveniently manage, and soon she has formed four open paper cells suspended mouth downwards from the disk, in each of which she then deposits an egg. More paper pulp is then brought, and presently the cells are covered with a kind of umbrella. Each time as she leaves the burrow she drops outside a piece of soil, for she is excavating as well as building. Other cells are then added around the first four, the base being extended to receive them. Such is the beginning of the first comb of cells, which, unlike the perpendicular combs of the honey bee, are arranged horizontally. while the horizontal

H. Bastin

INTERIOR AND EXTERIOR VIEWS OF A FINE NEST OF GROUND-WASPS
The lower photograph shows a nest with the outside layer of " paper " removed to show the plan of construction. The combs are built horizontally, not vertically, as is the case with bees, and further, no food is stored in their cells. Above is a photograph obtained by scraping away some of the earth from a bank in which some ground-wasps had hollowed out a cavity.

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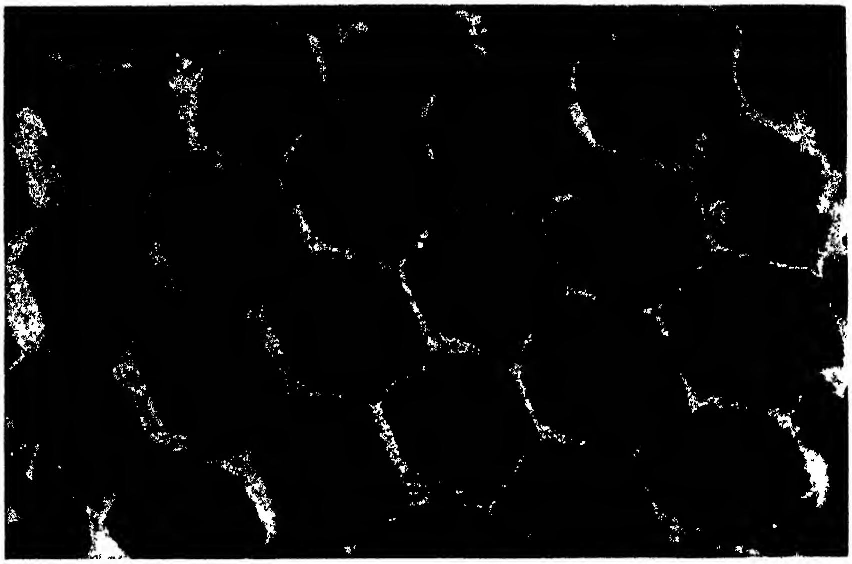
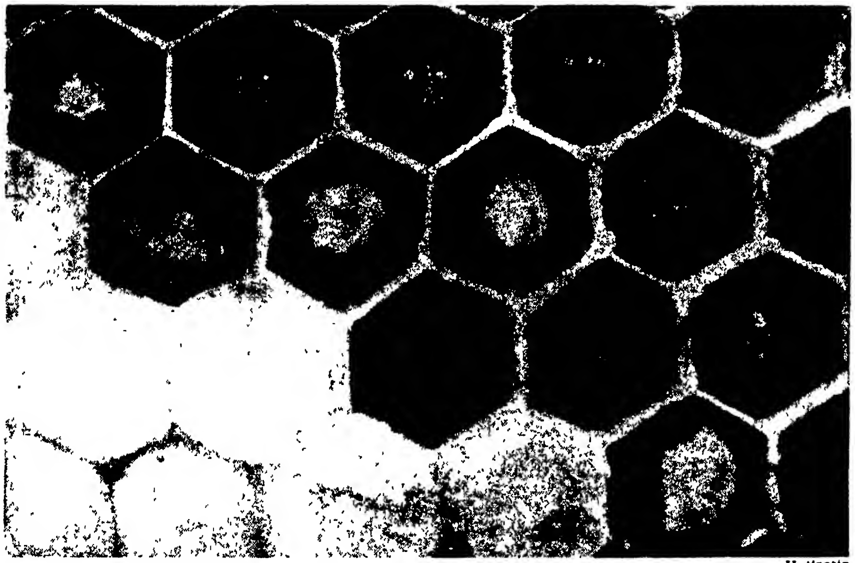
QUEEN WASP AT WORK IN HER WONDERFUL REALM OF PAPER

Queen wasps not only rule but found their city states. Each queen wanders away in search of a suitable nesting site and, having selected one, begins to manufacture "wasp paper" out of wood pulp and to construct the nucleus of the nest. She lays eggs in the first few cells, and as she goes on with her work these eventually hatch into workers, who assist her at the ever-increasing task of feeding the helpless grubs. Eventually the queen is set free from every duty but egg-laying. Below we see her attended by workers and above, laying eggs.

cells of the honey bee also differ from those of the wasp, the cells of the latter being set in the perpendicular position mouth downwards.

The queen wasp has not got very far with her work when the eggs laid in the first four cells hatch into wasp grubs. Then this so-called "queen," who is really a maid of all work, has to feed her offspring. She goes out to seek for aphides, tiny caterpillars, and similar tender meat for her hungry babies. With a mouthful of such food nicely minced she returns and feeds them from beneath as they hang suspended head downwards. They cannot fall from their cells, for they are firmly fastened to the base of their egg-shell. The grubs grow rapidly, and their busy mother in her spare moments, when not feeding them, continues to make more new cells, putting an egg in each one as it is completed to her satisfaction.





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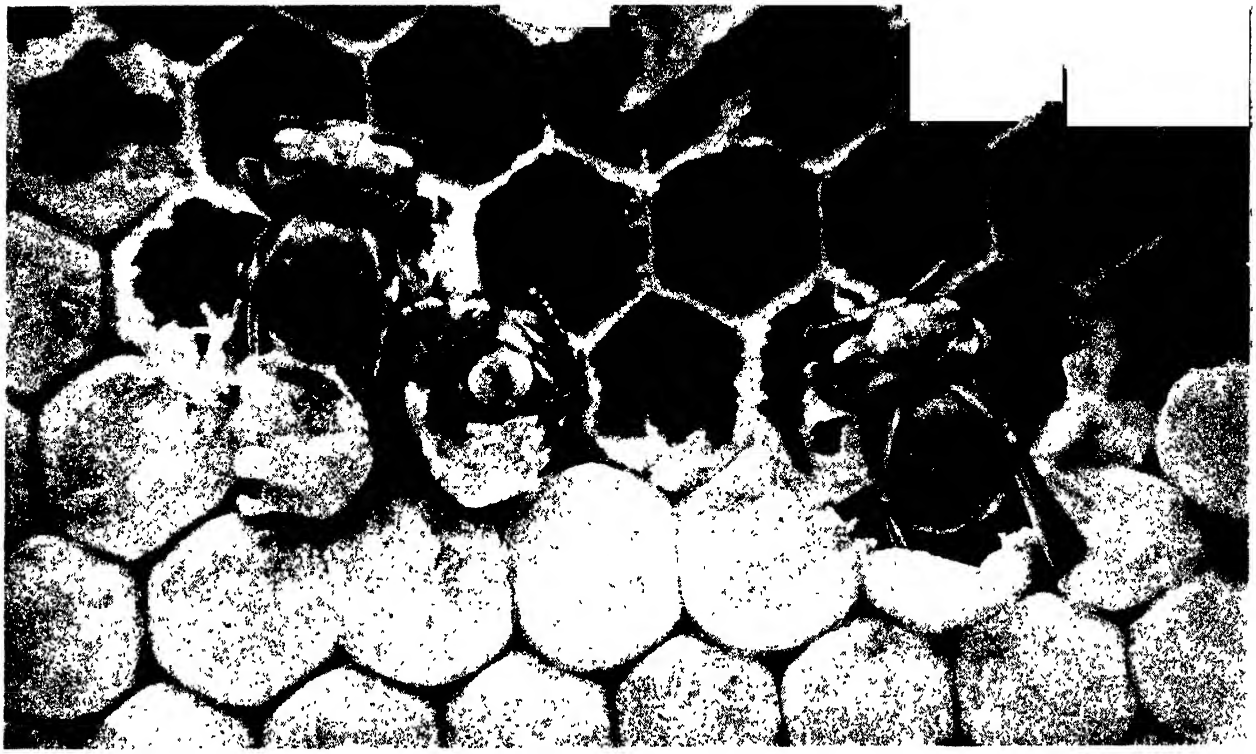
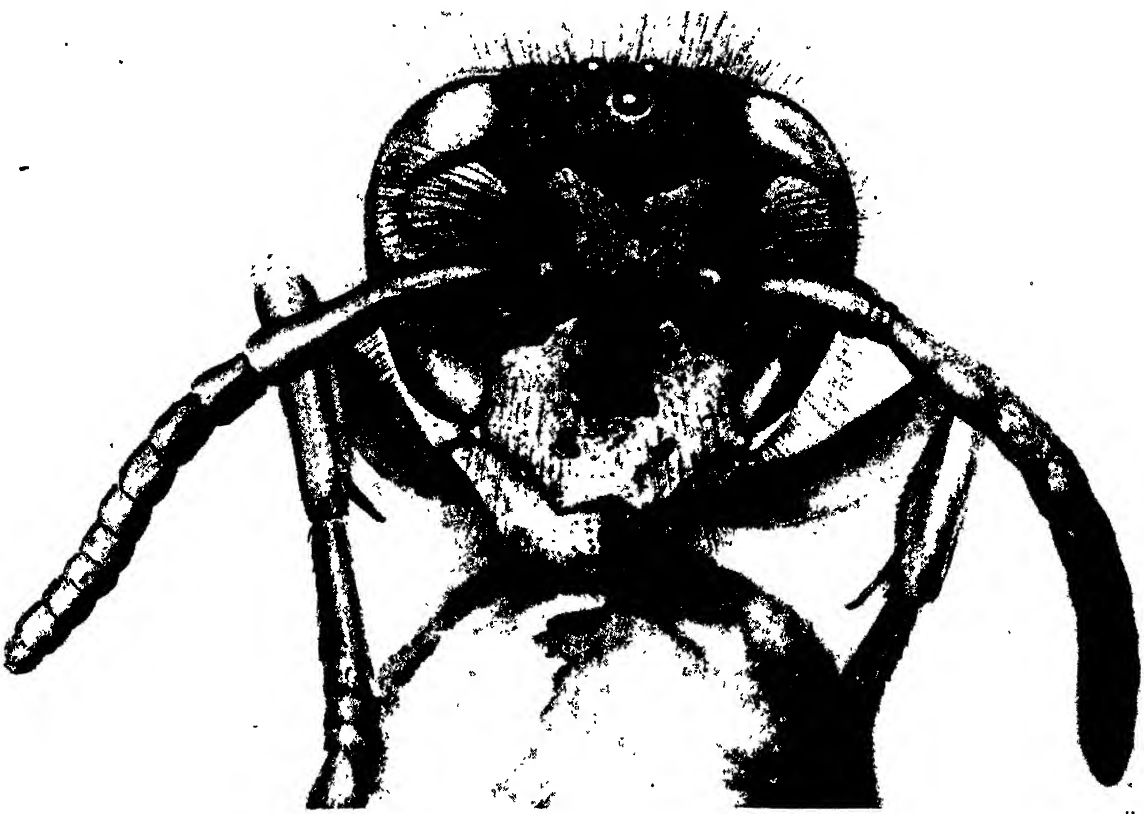
GRUBS AND EGGS IN THE CELLS WHERE THEY GROW

Wasp eggs are, as they are laid, stuck to the side of the cells, one to each cell, at right angles to the cell wall. When the grubs have hatched and grown they, in time, seal up the mouth of their cells with a white, domed cap of silk and become pupae. Below are some cells, those to the left being capped, and the upper photograph shows some eggs as they are stuck to the cells Both photographs are magnified.

Meanwhile the ravenous wasp grubs call for more and more food, while new baby grubs are continually hatching out from eggs in the later made cells. Nothing daunted, the mother wasp works harder and harder, and, in her quest for food, she boldly stalks unsuspecting flies, pouncing on to them while they are resting and rolling them over so that they suddenly find themselves a wing short, cut off by her sharp mandibles While the fly is discovering its injury its other wing is removed, and maybe its head; its body then being converted into minced meat for the wasp's hungry family at home. At this season sweet food is not needed: her children are carnivorous and they must have meat provender. A squashed caterpillar on the garden path will serve her equally well; she will remove it piece by piece; that, indeed, is the function of the wasp; she is first and foremost a very hungry scavenger of all forms of flesh food.

If by any chance she, or her workers that come later, should in their area of work enclose a butcher's shop, that is a glad event, for there flies can always be found without loss of time; and the butcher's board provides a splendid stalking ground. Sometimes in stalking a fly that happens to alight upon the meat the wasp's mandibles get a grip of the beef, and then the wasp makes a discovery—it finds that beef is better than flies. After that happening it returns many times, but for bits of beef and not for flies. That is a sad story, for the wasp's morals were led astray; that was not its natural function. Its intentions were of the best, but temptation was put in its way. It was still continuing its scavengering work in removing dead flesh food, although it is difficult to get the butcher to appreciate that point. We should remember, too, that by far the greater number of wasps are never fortunate enough to find a butcher's shop, or even a village, yet they successfully rear their families in the wild





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WORKER WASP FACE TO FACE AND WORKERS EMERGING FROM THEIR CELLS

Face to face, a worker wasp looks like something from a story by Edgar Allan Poe when enlarged to the size we see it here. The insect was photographed as it sat on a twig, and the camera lens was placed so that the wasp looked right into it. The upper photograph shows part of a comb in a wasp's nest enlarged with some young workers just breaking their way out of the cells they have sealed for themselves. As can be seen by the empty cells above them, some of their fellow workers have already got out into the world.

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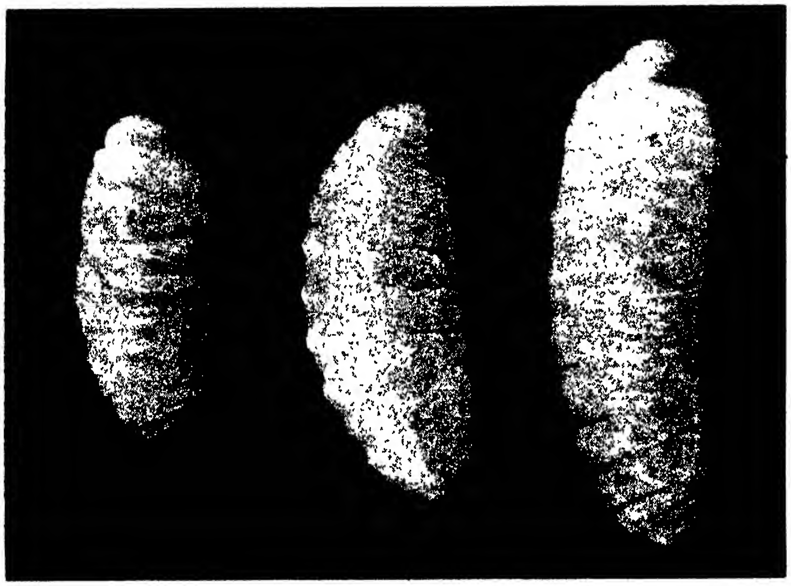
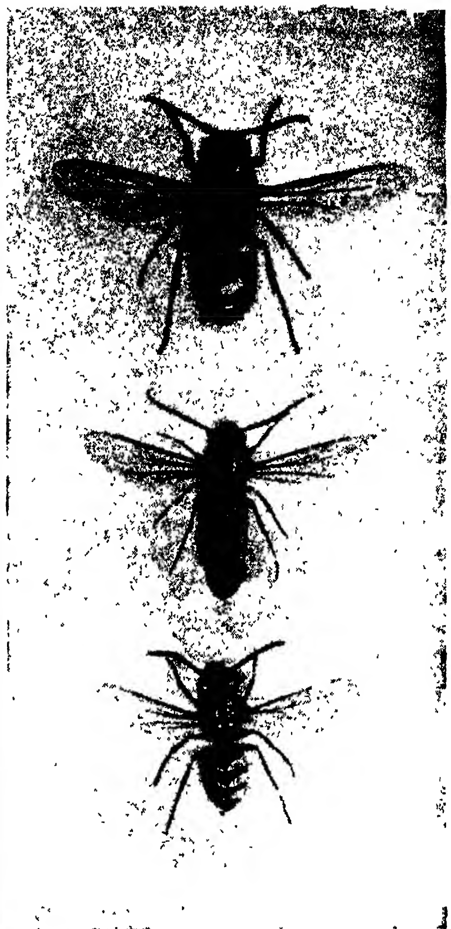
HEADS OF WASP AND HORNET, AND A QUEEN WASP HIBERNATING

When the queen wasp hibernates she seeks out some sheltered place, takes a firm grip with her jaws and folds her wings beneath her abdomen. The lower left hand photograph shows the underside of her head, with two pairs of legs and the antennae, while the upper photograph shows the whole insect clinging to a piece of rotten wood. She generally hangs tail downward. The lower right-hand illustration is of a hornet taken looking straight into the lens of the camera. These photographs are all greatly magnified

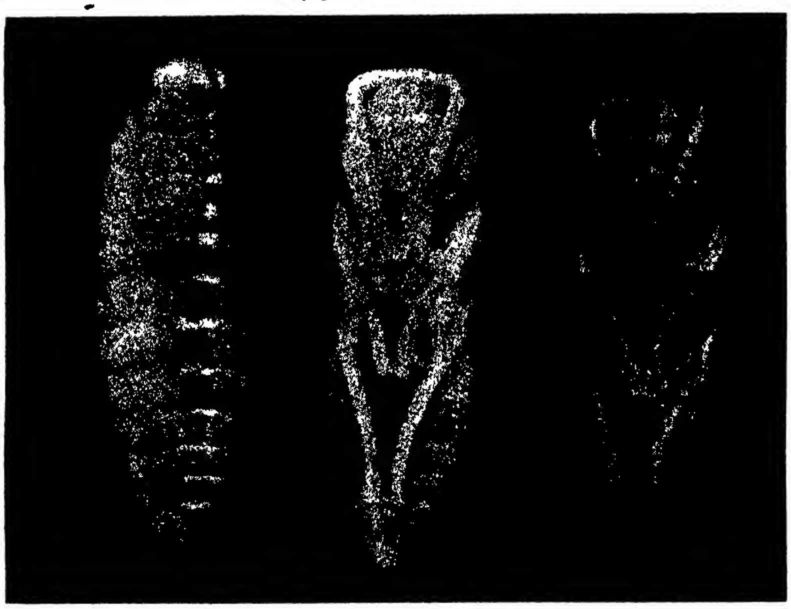
Three stages of the wasp's egg



Wasp grubs at various stages



Queen (top), drone (middle), worker (bottom)



Full grown grub (left) and two wasp pupae

Point of wasp's sting and needle-point (right)

WASP'S LIFE FROM EGG TO IMAGO, AND THE PAINFUL STING

The three eggs seen in the top left photograph were left attached to the fragments of cell so that they should not be damaged. These illustrations, all magnified, give us the story of a worker wasp's life. The larvae (centre left), which cling to their cell by means of a "foot" at their hind end, transfer themselves a few days after hatching to the end of the cell, where they hang head downward. The imagos, or perfect insects, are also shown here, and a sting compared with a fine sewing needle. The photographs are by H. Bastin

When some two dozen or so cells are formed the wasp grubs that first hatched out are full fed, and they themselves seal in the tops of their cells, secreting from their mouths a kind of liquid silk, which they spread on the interior of their cells and finally form a closing cap with it. The cell then becomes a cocoon for the development of the pupa stage. The mother wasp has no interest in the closed cells, her attention being fully occupied in feeding her increasing family. She exhibits a motherly instinct quite unknown to the queen honey bee.

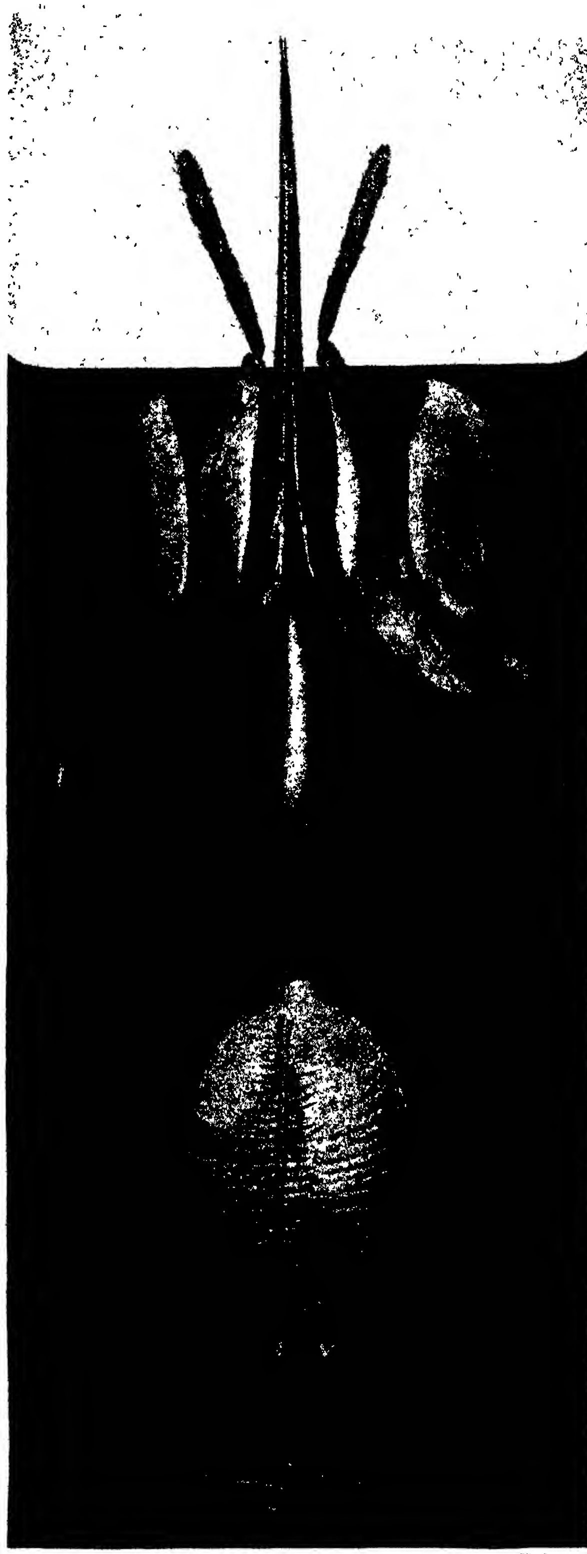
Some ten or twelve days later the inmates of the first four closed cells have matured, when they bite their way out. That is, indeed, a glad day for the mother queen, for she then has four (sexually imperfect) daughters, all as able as herself to go out and capture food for her growing family. The advent of these first workers is but the beginning of continually increasing assistance, for they have scarcely got working before other workers emerge from their cells. Presently the mother wasp is entirely relieved of feeding her young, or at least from having to go out to seek for food. She is content to superintend generally in the nest, and to deposit eggs as fast as her daughters can build cells to receive them.

By the time that the first workers have appeared the queen has herself constructed a complete little nest with one comb of about two dozen cells, but with the advent of the increasing force of workers the cover of this nest is soon cut away for enlargement, and the comb area is likewise extended. Then a short strong pillar is lowered from the centre of the first comb, on the end of which three or four cells are built, other cells then being added outside these with further pillars to support them. In that manner a second floor, or comb, is constructed. From seven to ten combs are eventually formed, the largest at the centre containing from three to four thousand cells.

The cells in the larger combs are used at least three times, for, as the worker wasps emerge, other workers tear off the remnants of the covering caps of the cells and clean them out in readiness for the queen to lay in them other eggs. So the tide of life spreads from the centre of the comb to the outer margin and then recommences again at the centre. Between the combs is just sufficient room for the workers to move about while tending the suspended wasp grubs.

As the nest grows a small army of the older workers have to become miners and excavate around the nest, carrying mouthful after mouthful of soil to the outside of the burrow.

When autumn approaches large cells are formed on the two lower combs, and these cells when closed have rounded instead of flat tops. They contain grubs which have had special feeding to produce queens and males—the parents of the colony for the following year. By this time the outer envelope of the nest may consist of eight or more sheets of wasp paper, every particle of which has been formed by the many thousands of workers, each one bringing in its mouthful of wood pulp.



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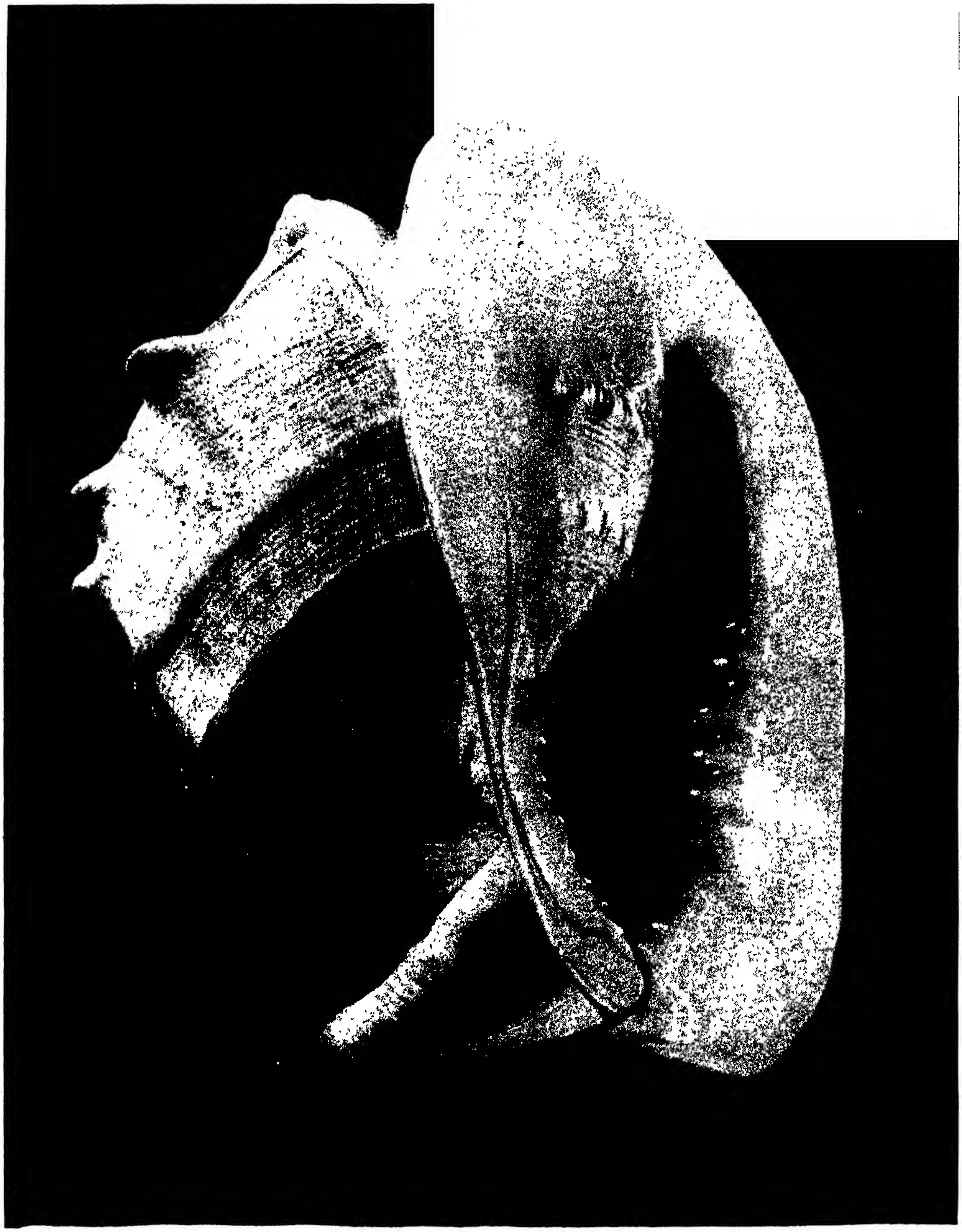
MODEL OF WASP'S POISON APPARATUS

At the bottom are the poison glands communicating with the poison bag. This last is in turn joined by a tube to the hollow "director" the sting itself. Only the top of the sting and two of its special feelers are outside the wasp's body



GLORIOUS DESIGN OF THE SHELL BELONGING TO A SEA SNAIL

Sea snails of the family Cassididae possess thick, massive shells, which have found much favour among carvers of cameos. The particular species seen above goes by the name of *Cassis Cornuta* and it is put on its side so that the magnificently serrated inner lips can be seen to full advantage. The spirals of the shell, seen behind, are equipped with a number of jagged projections. The rich variety and glorious workmanship found in sea shells used to be shown off under glass cases in many a wealthy home of the early nineteenth century.

Chapter LXXIX

The Wonder of the Sea-Shells

By Edward Step

Author of "Shell Life"

MUCH of the effete matter from the decay of living things on land finds its way in time to the ocean, via Nature's mighty drainage system; the sluggish brooks emptying into the swifter streams, and these into the larger rivers that flow into the sea, charged with great volumes of solid matter in solution—mineral, vegetable, and animal.

Triturated or, at least, broken fine, in the sea it finds multitudes of creatures waiting to avail themselves of this abundant food: minute transparent forms absorbing microscopic particles, and these in turn feeding larger animals, including great fishes and the greater sea-mammals, the porpoises and huge whales. Among the intermediate animals thus fed is the wonderful race of molluscs, with its infinite variety of forms that have fitted themselves for filling innumerable situations in the sea, and have modified their shapes and their protective armour to fit their mode of life.

When Man came and some of his tribes settled along the coasts they found by experiment that many of these molluscs were good eating, and were more easily obtainable than the fishes of deep water, which appear to have been left for a much later generation. In time these marine molluscs became known as shell-fish, a name shared by crabs and lobsters but no longer applicable, as the recognized fishes of to-day have internal skeletons. That early man availed himself largely of the molluscs as food is proved by the enormous percentage of sea-shells found in the ancient kitchen-middens in various parts of Europe, and by the continuance of the practice on some of the shores of Britain to-day.

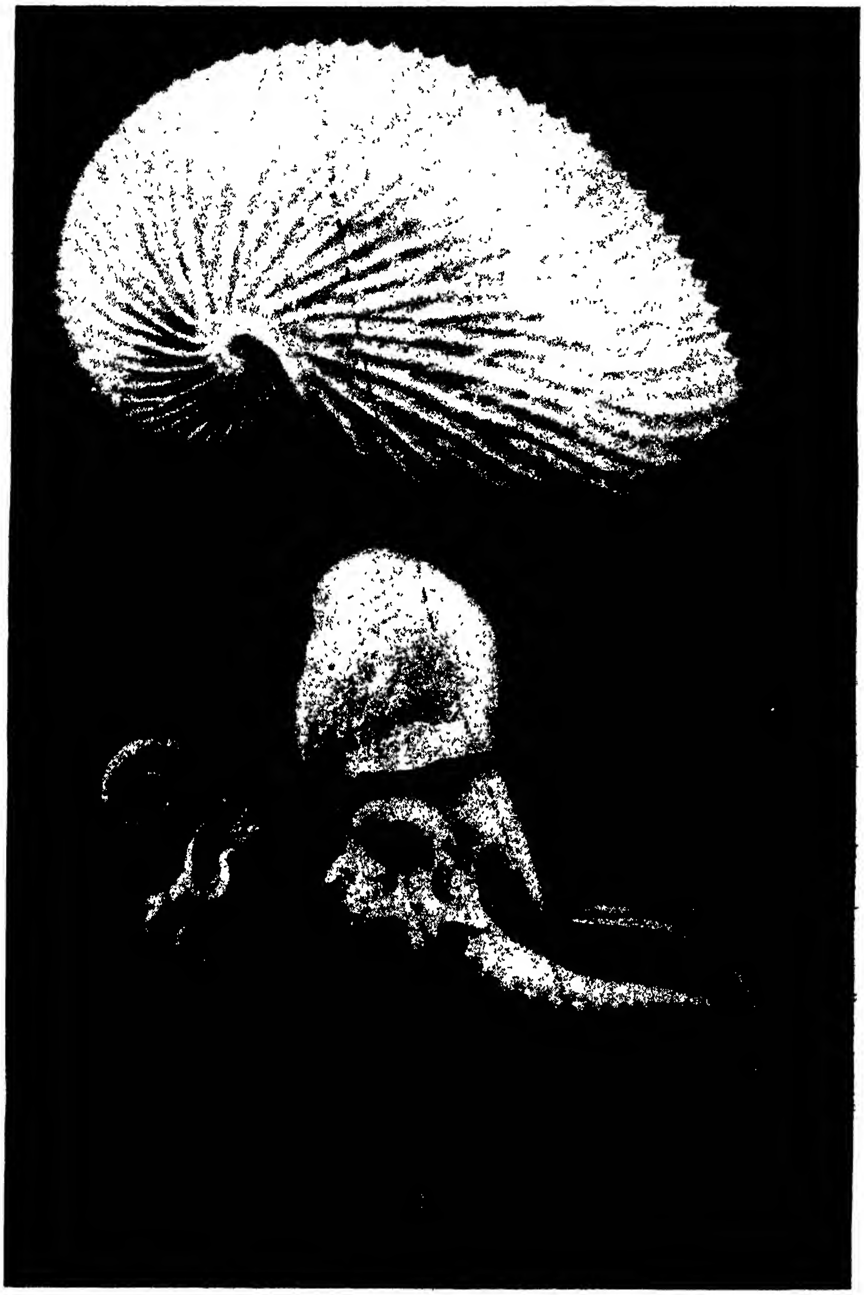
A few generations back it was the correct thing for the wealthy to possess a cabinet of shells, not because the owner had any interest in natural history, but because the specimens were beautiful, quaint or rare—and the rarest were the most desirable, whether they had beauty or not. They were "curios." Mostly exotic, some that came only rarely from far eastern waters realized high prices in the sale-room. Though much admiration might be evoked by their strange forms and wonderful coloration, their importance to the animals that built them for their protection was scarcely considered; and the animals themselves did not come into the picture. The owner prided himself upon his perfect examples of the rare glory of the sea and the precious wentletrap, his big harps, helmets, mitres, cowries and cones.

Yet these same shells were marvellous in a way that their owners never realized—the method by which they had been fashioned, the purpose they served in the life of the artificer, and the wonderful mechanism for the security of those that were in two parts.

The living animal that produces these wonderful shells is always very soft; yet it has various internal organs—such as heart, stomach, liver, nervous system, and so on—analogous to those of the backboned animals. The body is wrapped by a sort of cloak (known as the mantle), which has the power of secreting carbonate of lime mixed with animal matter on its outer surface. This hardens until it is more or less stony, and successive layers are added within and at the edges as the animal's increasing bulk requires. The molluscs, as a phylum, or division of animal life, are separated by naturalists into five classes, of which we are chiefly concerned here with two classes—the snail-like gastropods and the mussel-like bivalves. It will be seen that, apart from the possession of a hard shell, there is no external resemblance

PREDATORY SNAILS OF THE INDIAN OCEAN

In the type of sea-snail called Murex the shell is commonly long and inclined to be jagged. This specimen comes from Ceylon and, like its relatives, is equipped with a rasplike tongue for boring through the shells of other molluscs on which this snail preys.



FEMALE ARGONAUT AND HER ELEGANT SHELL

Here we have a sea creature the female of which makes for herself, by means of a special secretion, a very elegant shell. In this the eggs are developed The body, here seen separated from its shell, is not unlike that of an octopus, the two creatures both belonging to the class of cephalopods. The body is from a model in the Natural History Museum. Kensington.

between these two classes; and to appearance there is little in the animals themselves.

The gastropods have the principal part of the body elongated: it is known as the foot, because its underside is flat and sole-like. At the front end of the foot is a distinct head, with eyes and other sense organs, and a mouth furnished with a ribbon-shaped "tongue" which is beset with rows of flinty hooks for rasping food. Upon the flat foot the mollusc glides over rocks and seaweeds in search of food. These animals are usually unsymmetrical, the body being coiled spirally, and the shell, being moulded upon it, takes the same form. In some species there is attached to the hinder part of the foot a shelly or horny plate (operculum) which, when the animal withdraws into the shell, closes the entrance. It might be thought that, as the mouth of the shell increased its diameter with the general growth, this tail-plate would soon get too small to act as a door; but it must be remembered that when closed the plate is in contact with the edge of the mantle, which lines the shell, and in that way receives additions to its circumference. Muscles attached to the shell pull the animal within.

THE animal that constructs and lives in the double, or bivalve shell is usually symmetrical, and its mantle is divided into two large lobes, which explains why the shell is formed in two separate pieces. As growth of the body takes place, the valves are enlarged by equal additions to their margins. This bivalve is a more sedentary animal than the gastropod. Although he has a foot he does not glide upon it, but uses it mostly for the purpose of burrowing into the sand or mud and pulling himself down with its aid. There are some exceptions, which are active after a fashion different from that of the gastropods; but the sedentary life has led to the degeneration of the class from a higher type. This decline is seen, among other items, in the loss of the head and its attachments. There is a mouth, of course, but it has no ribbon-tongue such as has been referred to: it can take in only the minute food that is brought to it in currents of water set up by the waving of filaments on the gills.

Like the naked molluscs of the land—the slugs—there are molluscs of the sea that have no shell, or only a small one concealed by the mantle A slightly

more advanced class—regarded from the shell point of view, but not structurally—has the upper surface protected by eight small, overlapping plates, margined by the mantle. These are the mail-shells, or chitons, which are able to roll up like woodlice for protection.

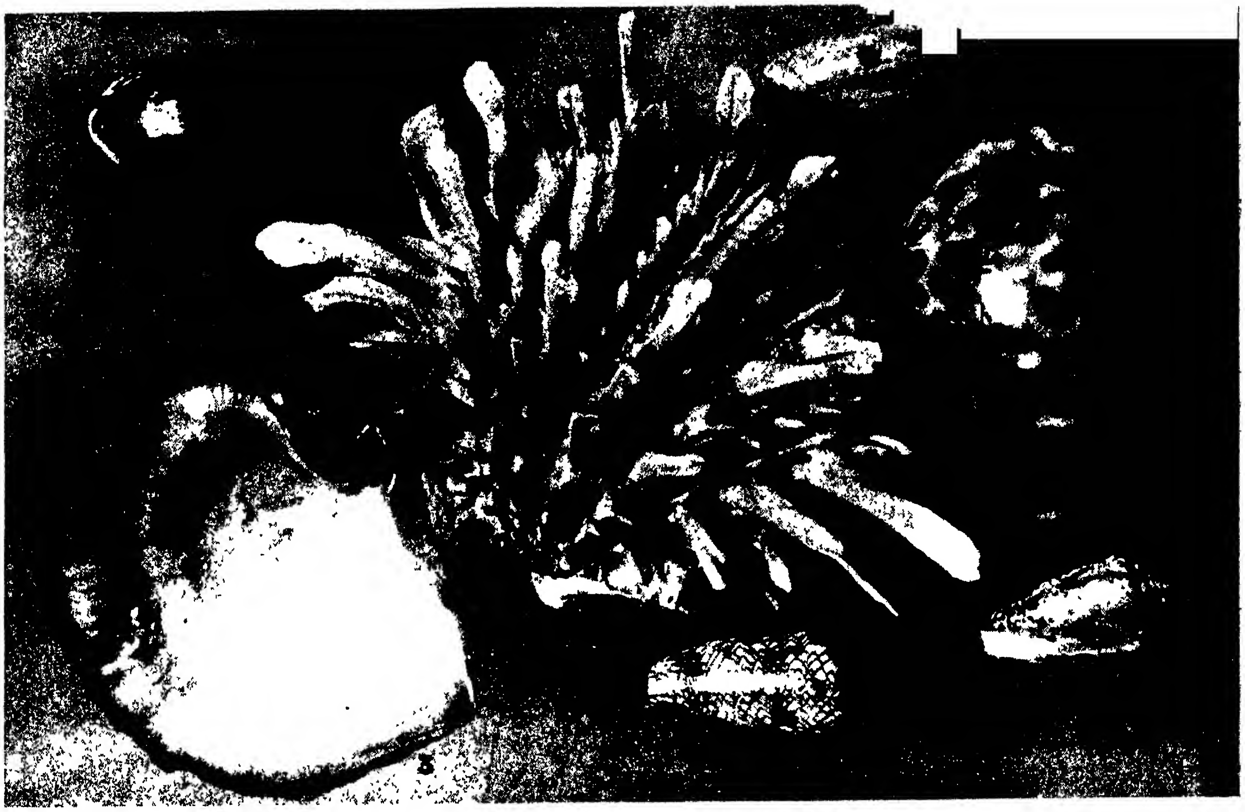
The simplest form of undivided shell is that of the limpets, one of them a very conspicuous feature of rocky coasts, where the animal is used as a handy bait for fishing, and in some places as human food. The limpet, consequently, is familiar to all; and it will be remembered that its shell is a hollow, low cone. Our wealthy collector of the past may not have admitted so vulgar and obscure a shell to his cabinet; and the ordinary wanderer along the shore to-day passes it by as uninteresting, though it studs the reef in thousands. A little time given to its consideration may help us to an understanding of the part that form and colour of the shell play in the life of our molluscs.

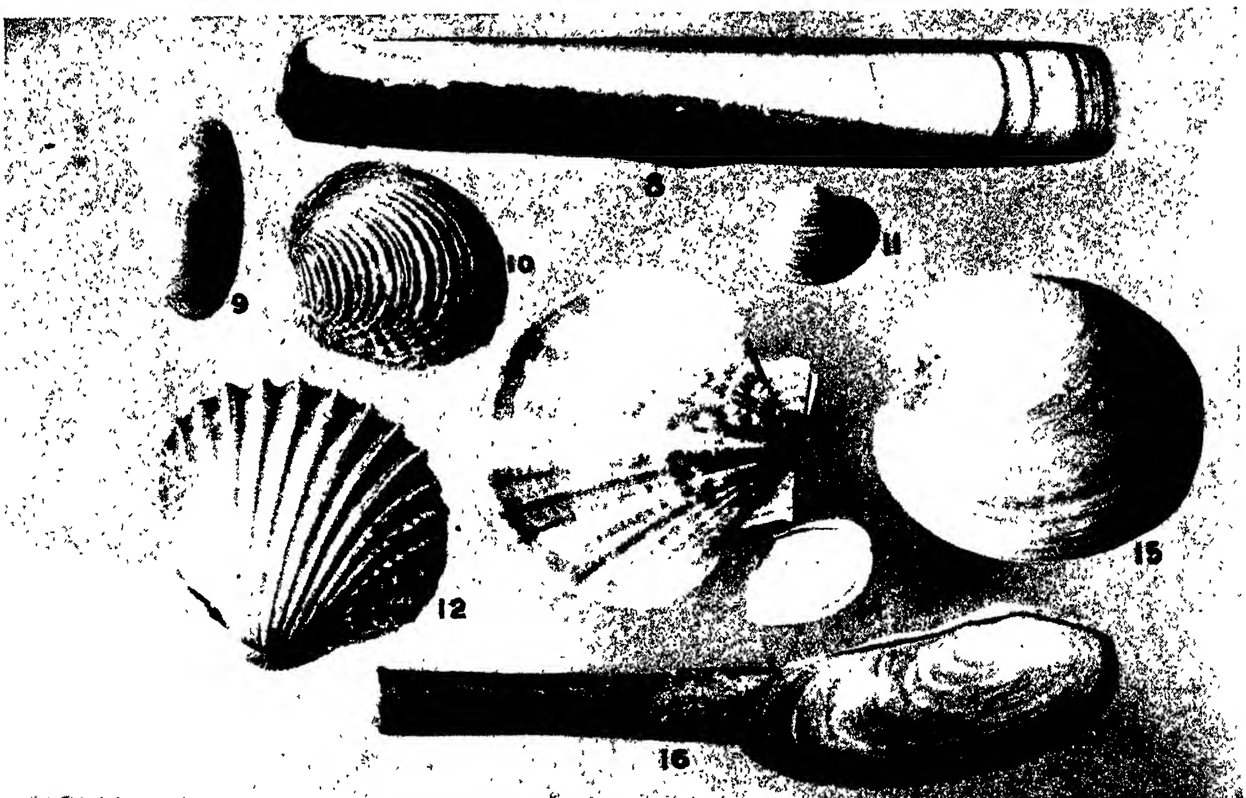
ARGONAUT OF THE MEDITERRANEAN, SWIMMING

Amid an intricate trailing of languid tentacles the little argonaut writhes gently through the sun-warmed sea. Progress is made by the expulsion of water through a special funnel, just as in the case of the cuttle-fish, a larger relative of the argonaut. The shell is formed of a secretion from two of the tentacles. This specimen comes from the Mediterranean.

If the tide has just receded from the rocks, we may see the limpet in motion, the shell oscillating a little as the animal is adjusting itself to a correct position in a depression clear of acorn-barnacles and corresponding to the outline of the limpet's shell. During the period of high-water the limpet has been wandering around with its toothed ribbon scraping off the delicate growth of young seaweeds within a radius of several feet. We can see where it has been at work by the cleared zigzag lines it has left. Now, having settled itself into the proper position, it takes firm hold with its broad, oval foot, and draws the edges of the shell down into close contact with the rock. There it will remain until the tide is running up the shore again.

Looking at the limpet in repose, we can understand that should a heavy sea spring up and attack the rocks in great force, the form of the shell will offer little resistance: the low angle will permit the waters to glide harmlessly over it. Another important feature is that in its resting position the shore-birds cannot attack it: it is only when the limpet has its shell raised in movement—mainly performed under water—that even the oyster-catcher can prise the shell from its hold and nip out the mollusc. From this tent-like form most of the shells of gastropods have probably been evolved. Several molluscs structurally different have low,

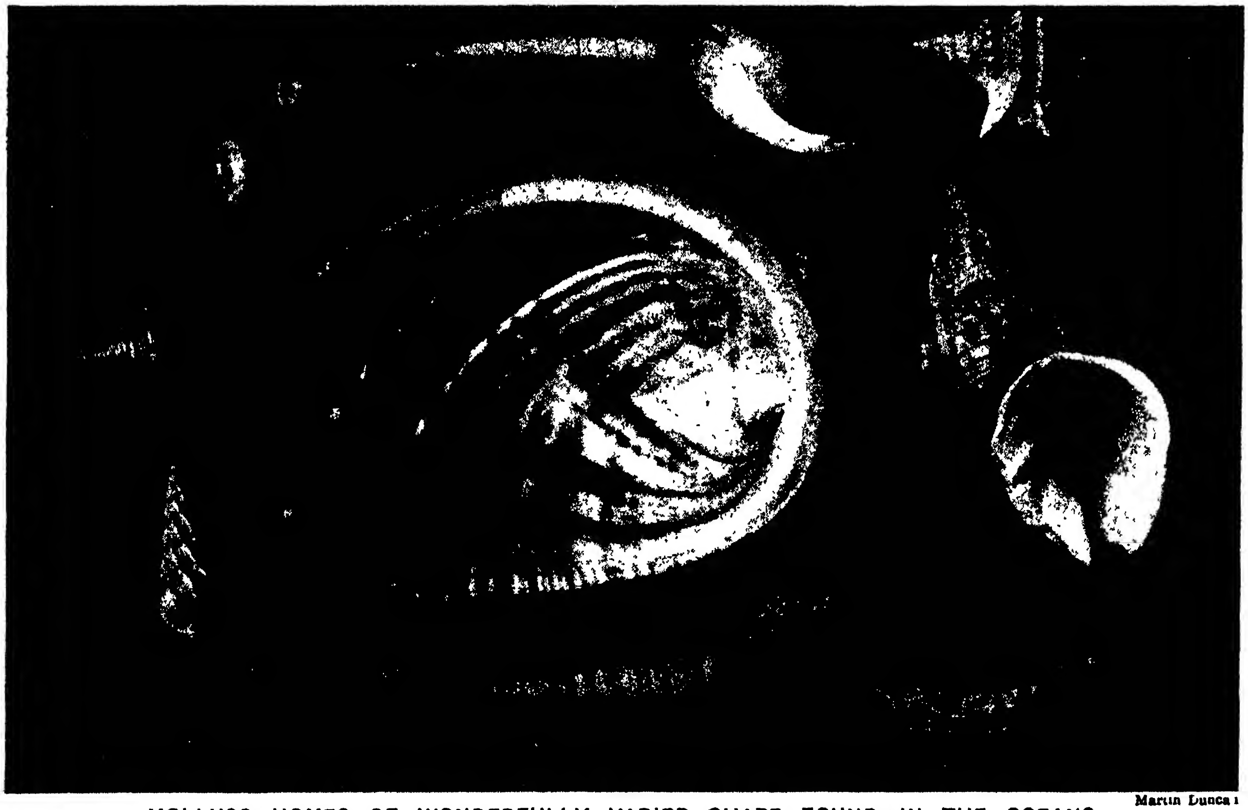




Martin Duncan

SHELLS COMMON AND UNCOMMON DISCOVERED ON BEACH AND SEA-FLOOR

As numbered here the shells in the top photograph are: 1. Cowrie. 2. Olive shell. 3. Pearl oyster. 4. Spondylus. 5. Leopard cowrie. 6. Conus gloria maris. 7. Conus acuminatus. In the lower photograph we have: 8. Razor shell. 9. Donax variegatus. 10. Venus verrucosa. 11. Venus casina. 12. Prickly cockle. 13. Queen scallop. 14. Tellina tenuis. 15. Cap-of-Liberty. 16. Otter's shell. The venus shells, of which we have two examples in the lower photograph, are found usually between high and low watermarks.



Martin Duncan

MOLLUSC HOMES OF WONDERFULLY VARIED SHAPE FOUND IN THE OCEANS

These shells (top) are examples of: 1. The venus shell—Venus casina. 2. Great piddock. 3. Prickly cockle. 4. Lima nians. 5. Ormer or ear shell (showing the outer surface). 6. Short piddock. 7. Otter's shell. 8. Cap-of-Liberty or heart cockle. Below are: 9. Sea snail. 10. Winkle. 11. Tusk shell. 12. Boat shell. 13. Pelican's foot shell. 14. Top-shell. 15. Ormer or ear shell (inner surface). 16. Great whelk. 17. Ladder shell. 18. British cowrie. 19. Dog whelk. 20. Screw shell. 21. Rock winkle. 22. Limpet.

W. Saville-Kent

EXTRAORDINARY PEARL FORMATION BELIEVED BY THE FINDER TO HAVE BEEN A MIRACLE

During the year 1874 some pearl fishers, who happened to be Roman Catholics, were carrying on operations at a place called Raeburn in Western Australia. One of the number came upon the shell we see above and, on opening it, saw what he believed to be a miraculous sign. By some freak the oyster had formed not one but nine pearls, and they were arranged in the form of a cross. These joined pearls received the name of "The Southern Cross," and became famous in the annals of the industry.

smooth shells that conform to the same principle of non-resistance. Where more room was required for the safe housing of the resting animal the low cone became a comparatively high cone; but where similar exposure on shallow-water rocks would make this dangerous the cone was coiled obliquely and the general form was retained. This may be seen in the common top-shells and periwinkles. Some of these show, also, modifications of their sculpturing to fit their differing modes of life. Those that are, from their usual situation, most exposed to wave action have very low spires, and the depressed cone is smooth, whilst those that frequent sandy or pebbly shores where their foothold is precarious have the shell decorated with knobs and ridges to prevent them from rolling unduly when swept by the waves. Corresponding adaptation will be found in all the common shells of the shore, whether the animals live by cropping the tender seaweeds and zoophytes from the rocks, feed upon the leathery wracks that are torn and twisted by the waves, or hunt for animal food in sheltered pools where there is very little disturbance of the waters.

W. Saville Kent

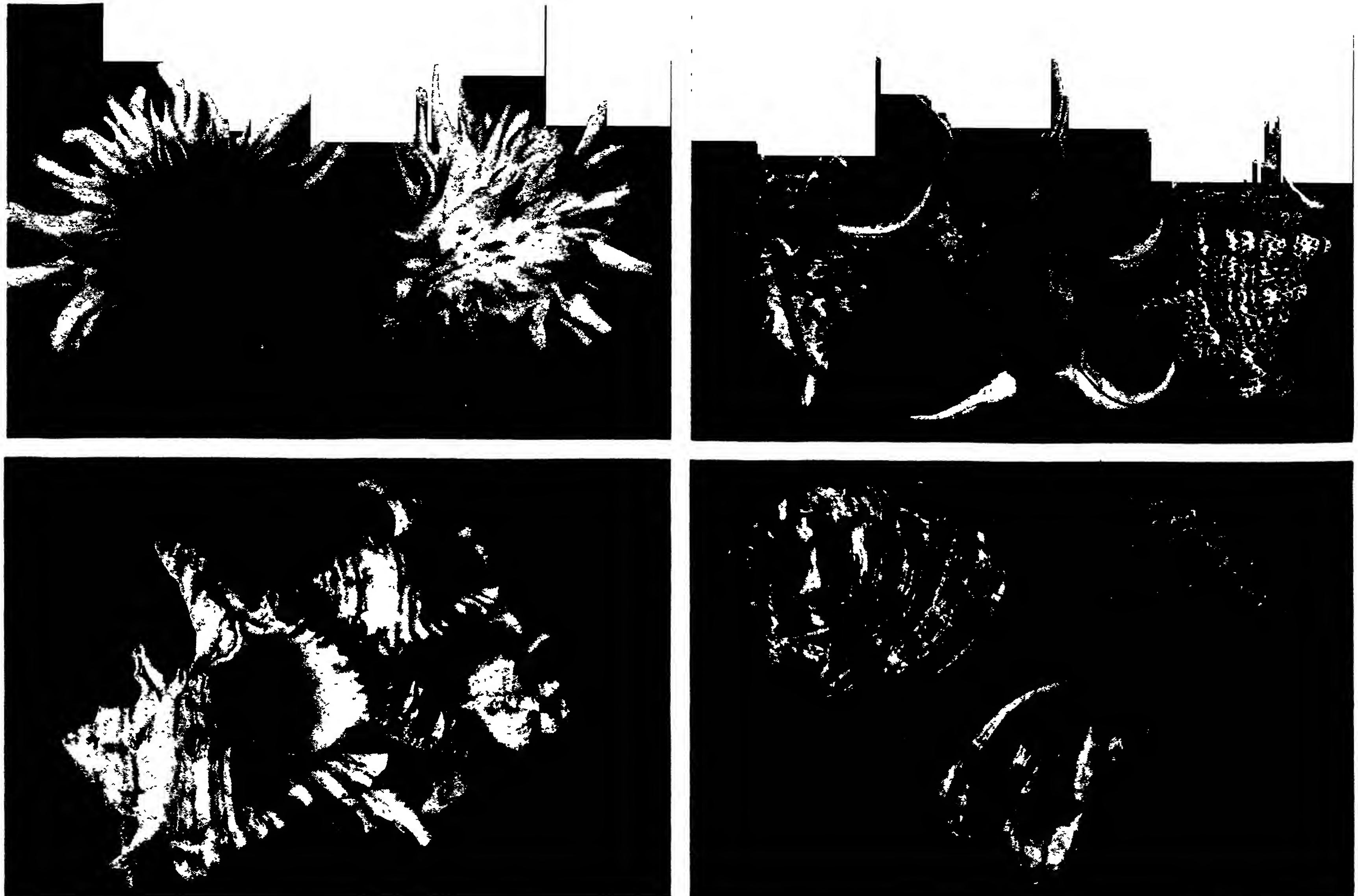
AUSTRALIAN PEARLS AS FOUND IN THE SHELLS.

These pearls come from Shark's Bay, a deep depression in the coast of Western Australia largely protected by islands from the force of the ocean. Here there has been great activity in the pearl industry. The pearl itself consists of layers of calcium carbonate laid down either round some foreign body, such as a grain of sand, or round the body of a parasite.

Some of the limpet-like shells have an aperture at the top or a slit in the edge for the admission of new water when the shell is closed down to the rock. Some, with evidently the same ancestry, have this aerating slit tucked into the thick lip of their spiral shells. In the whelks and many others of deeper water habit, the cone is very elongated, owing to the necessity of making constant additions to the newest part to accommodate the rapid growth of the animal. The upper part of the spiral may be quite unoccupied; and in some species the empty room is shut off by a partition being formed across it. Where less space is required in what is known as the body-whorl, the spire may become almost cylindrical and of great length relatively to its diameter, as seen in the British auger-shell, horn-shells, and needle-whelk.

The pelican's-foot shell in its younger state approaches this slender form, but when older the margin of the lip spreads out into several broad lobes, covering all but the easily-retracted head of the animal, which is extended into a proboscis. The tooth-ribbon of this and other carnivorous species is used as a drill which bores neatly through the shells of limpets and others upon whose inmates the borer feeds. The dog-whelk has similar tastes and methods; and the sting-winkle, whose shell is all rugged knobs and folds, getting a living by like means, is one of the greatest pests to the oyster-farmer on those parts of the coast where it is very common.

The alteration in form effected in the shell of the pelican's-foot between youth and maturity is not as great as that attained by a mere shifting of the opening of the shell more fully to the side, as may be seen in our little margin-shell, where the body-whorl accounts for about four-fifths of the entire length of the shell, the remainder being a small squat spire. The mouth is a narrow, undulating opening at the right-hand side of the body whorl the lip at first thin edged, but later much thickened and toothed. Now, if this lip were much expanded outwardly it would have the effect of bringing the mouth-slit nearly into the centre; and that is just what we find has happened to the shell of the cowries, of which there is a small but pretty representative on British shores. In the warmer oceans there are large cowries with fine coloration and a natural



J. J. Ward

THE WEIRDLY WROUGHT AND STRANGELY TWISTED HOMES OF SOME MOLLUSCS OF THE SEA

In this quartette of shell photographs we have (bottom left) a specimen of Ramosus from West Africa and (bottom right) some ormer or ear shells. They are sometimes washed up on the south coast of England and, in the Channel Islands, the animals inside are used for food. There are a number of perforations in the shell through which tentacles protrude when the creature is alive. These holes are the remains of what, at one stage in this mollusc's history, was a continuous slit in the last whorl of the shell. There is a corresponding slit in the mantle, that is the thin fleshy membrane which lines the shell. The shell of the thorny oyster, spondylus (top left), is beautifully coloured. The top right-hand illustration is of some wing-snails.


W. Saville Kent

SOBER COLOURED OUTSIDE OF A MOTHER-OF-PEARL SHELL

The exterior face of any shell in which mother-of-pearl is found does not hint at all at the glories within. As we see here, the shell seems to be composed of a number of strata, and there is a series of projections arranged in vertical rows. All this rough outside has to be scraped away until, gradually, the wonderful mother-of-pearl is arrived at. This has much the same composition as pearls. In the East they carve these shells—the finest specimens—with intricate figures so that the light, seen through the shell, varies with the depth of the carving.

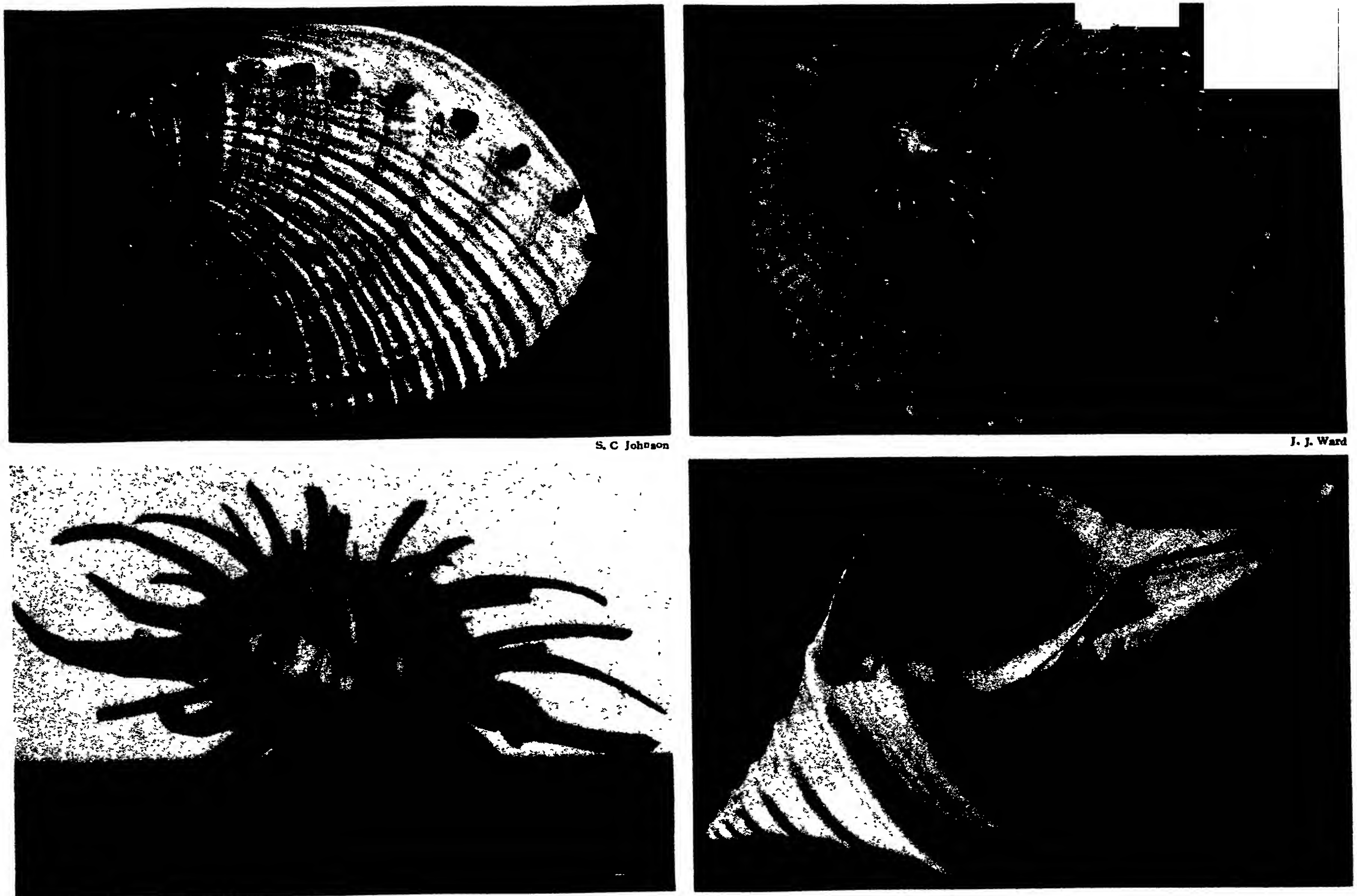
high polish, many of them treasured as parlour ornaments when brought home by travellers. A smaller, yellowish cowry from the Pacific is known as the money cowry from the fact that traders in Africa used it extensively as a medium for bartering.

OTHER gastropods with long expanded mouths keep them to the side, as in the large but light tun-shells and the heavier volutes, or music-shells whose internal coils act as a whispering gallery, giving out faint sounds which are fabled to be the murmur of the distant sea—Wordsworth's

> Murmurings, whereby the monitor expressed
> Mysterious union with its native sea.

As a contrast to these thick, heavy shells we have the keel-shell, a semi-transparent, open shell, though still spiral in its structure. It looks like a delicate piece of thin blown glass, so fine and rare that collectors of a hundred years ago were willing to give a hundred pounds in exchange for a specimen no bigger than half a walnut-shell, over which one must breathe lightly for fear it might be blown away. Its rarity and its delicacy are explained by the habit of its maker, a curious elongated creature with its foot developed into a fin, which enables it to swim in the upper waters and feed upon the smaller jelly-fishes and other floating animals, with the exquisite shell below it. Even to-day, when the habits and habitats of the animal are better known, a purchaser has to pay several pounds for the wrinkled shell.

Shells as delicate but more plentiful, and therefore of less value commercially, may be found on British shores; such are the Marsenia, the lobe-shells and bubble-shells; but they must be sought when the animal is alive. They are then enfolded by the mantle of the mollusc, which feeds upon the jelly-

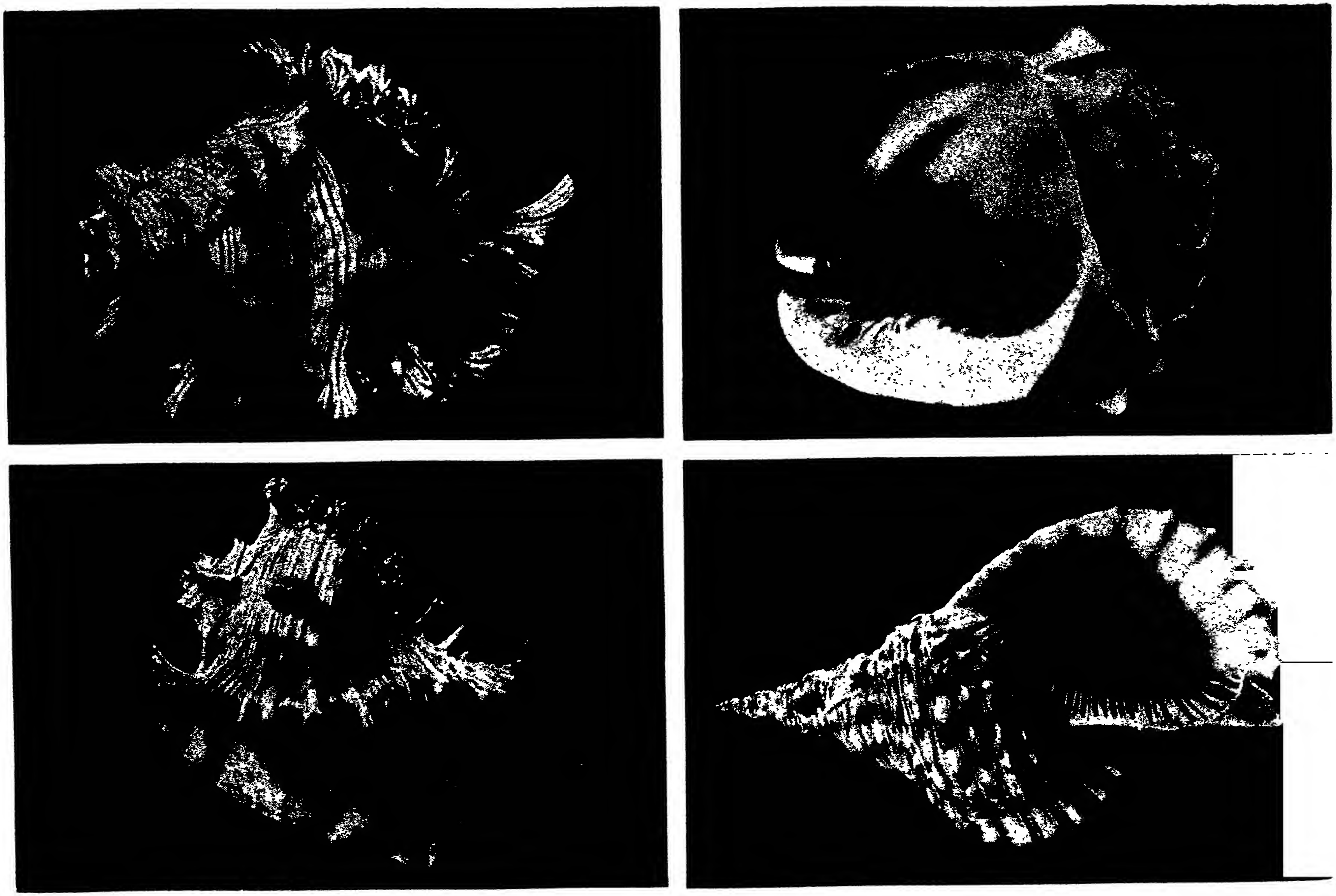


S. C Johnson

J. J. Ward

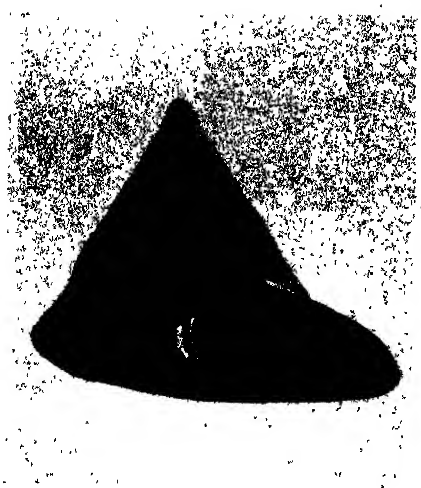
LOVELY SPECIMENS OF NATURE'S ART THAT ARE FASHIONED UNDER THE WAVES

The shells seen here are (bottom left) Spondylus Americanus; (bottom right) Fusus Proboscidiferus, which has a very elongated mouth and a spiral built up like a pagoda; an ormer shel (top left) with its row of perforations like port-holes in a ship's side and (top right) the shell of a paper nautilus. This last is one of the wonders of the deep and has a translucent shell beautifully ribbed, which serves to hold the eggs. The shell is not attached in any way to the creature it serves. Another name for the paper nautilus is argonaut, though strictly speaking i is only the Mediterranean species to which the name paper nautilus should be applied. The argonauts are members of the cuttle-fish family.



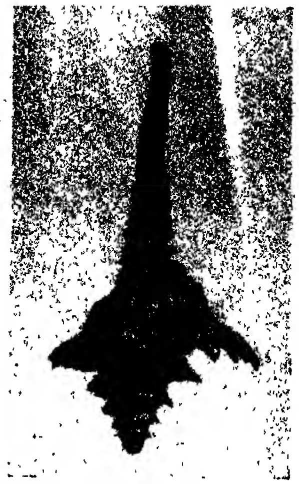
DIVERSE AND BEAUTIFUL SUITS OF ARMOUR FOR LOWLY CREATURES OF THE SEA FLOOR

In this page we have a model (bottom left) of Murex Ramosus from the Natural History Museum at South Kensington. The creature is inside and its protruding " stalks " and the " foot " on which it moves are all the living portions visible. The lower right-hand photograph is of a specimen of Triton Tritonis with an elegantly fluted mouth and a finely tapering whorl. Above are (top left) a specimen of Sinensis, a shell found in the seas between China and Japan, and (top right) the wide-mouthed Cassis Cameo from the West Indies. The word " cameo " in the nomenclature of the last-named shell reminds us that the exquisite work of the cameo artist depended for its perfection on the quality and texture of certain shells.



Papuina shell from New Guinea

Auger shells

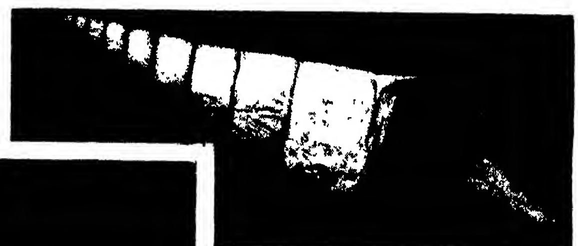


Deep-sea Pacific shell

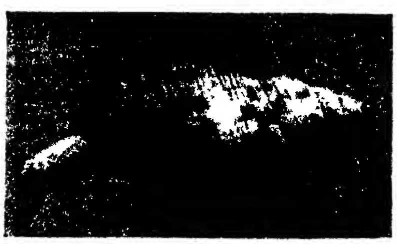
Cassidaria (left) and Cypraea (right

Cypraea (left) and harp-shell (right)

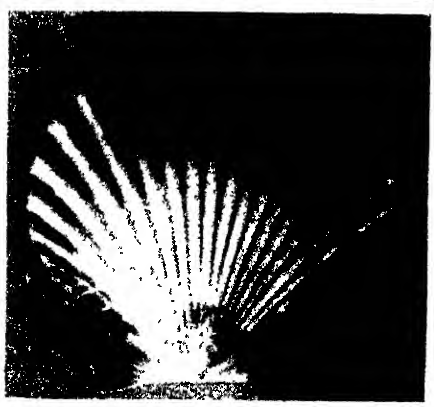
Volva shell



Rostellaria



Pheasant shell

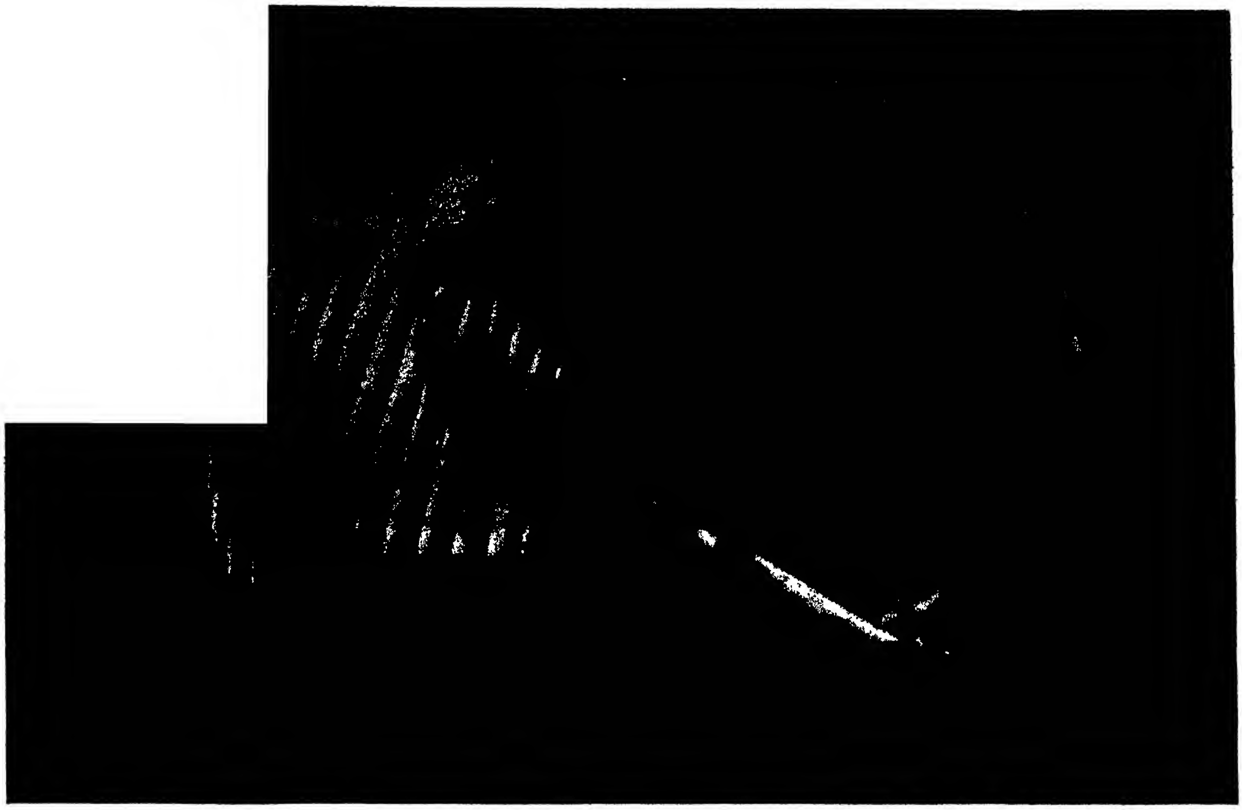


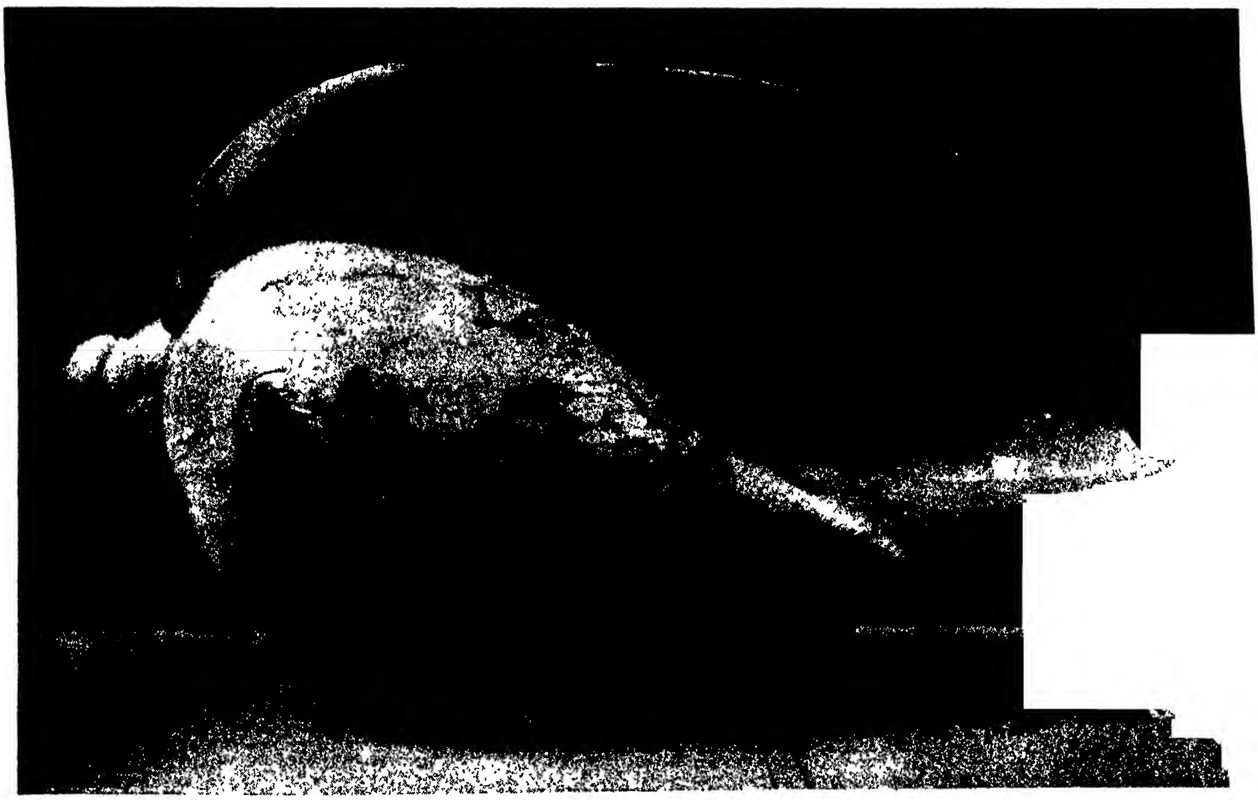
Scallop

Polynesian cone-shell

SEA MOLLUSCS IN THEIR INFINITE VARIETY THAT ARE FED ULTIMATELY BY THE LAND

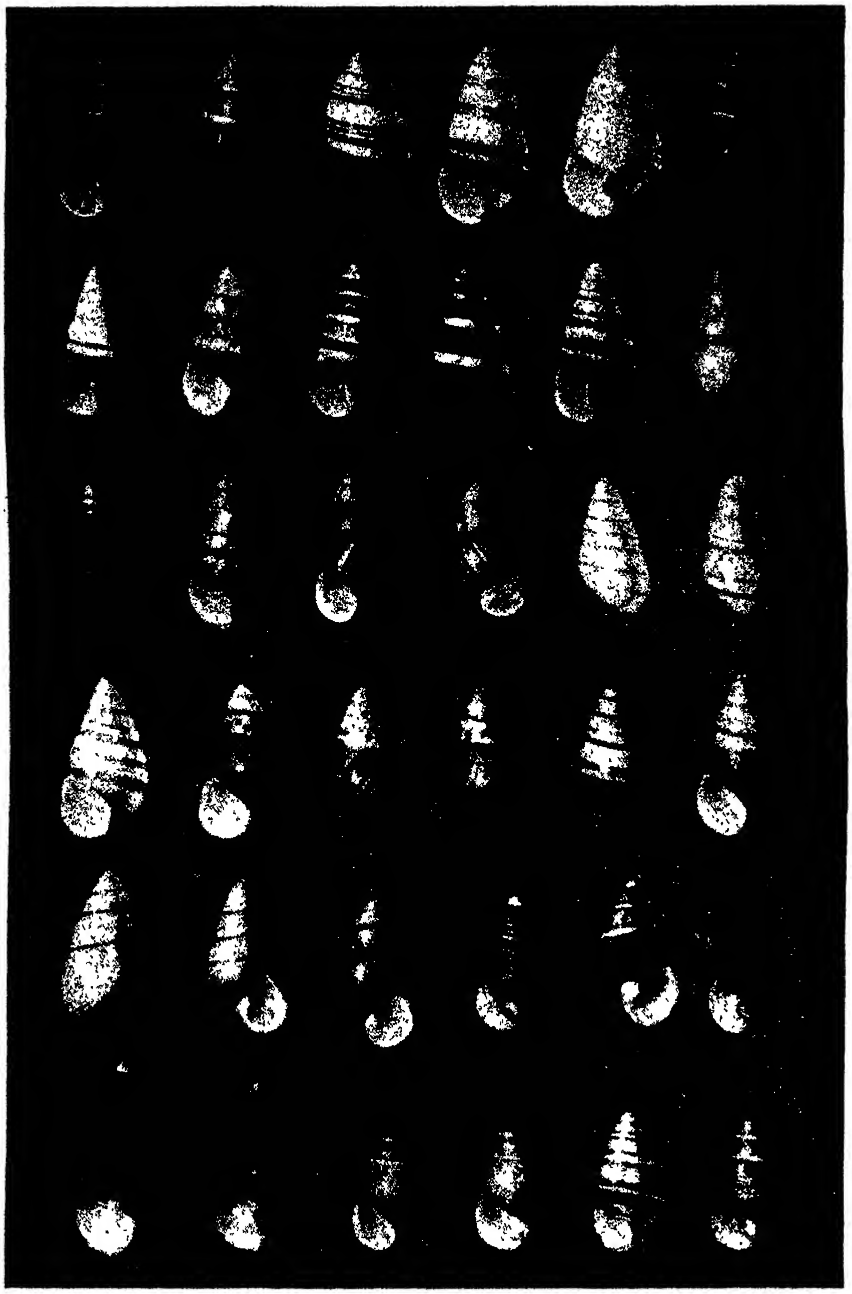
Life goes on under the sea much more intensively than on dry land. The oceans teem with life, but it must be remembered that this life draws much sustenance from the land. Water vapour, sucked up from the sea by the sun, discharges itself as rain upon the earth, and flows back to sea again in the rivers. In doing so it brings down with it a constant supply of decaying particles of what were living things, and this feeds a host of minute forms and these in turn feed larger creatures. Among the intermediate forms thus fed are the sea-molluscs.





SHELLS FROM TASMANIA AND HAWAII, WITH THEIR BEAUTIFUL MARKINGS

In the lower photograph we have an example of the Volutidae, which is the name for members of a division of the mollusc kingdom including many most elegant shells not only handsome in shape but also in colour and markings. This particular form, *Mamilla*, comes from Tasmania. The upper photograph is of a species of tun-snail. A feature of this class of molluscs is that the glands connected with the mouth secrete a liquid containing sulphuric acid which aids in the process of perforating the shells of other molluscs



E.N.A.

VARIATIONS IN THE BEAUTIFUL TREE SHELLS

These little creatures live on the leaves and the bark of trees growing in the remarkable Rain Forest which clothes the mountains overlooking Honolulu. Many of the shells are most vividly tinted, some displaying pink or green, while others are tricked out in red, gold and brown Such brilliance of colouring is more usually associated with sea than land molluscs.

It is well known by every reader that a large class of molluscs have the shell formed in two pieces, or valves, and are known consequently as bivalves. Of these the most familiar are the oyster, scallop, mussel and cockle. What has been said of the prevailing symmetry of bivalves scarcely fits the case of the oyster, which has unequal valves, the left, or lower valve being hollowed out and holding the animal, whilst the right, or upper valve is nearly flat. But the oyster in its infancy attaches its lower valve to the rock or stony bottom, and remains fixed for life—or until removed for the food of man.

In some species the two valves are kept closed tightly by the action of a strong central muscle that unites them, as in the oyster and the scallop; but in most species there are two such adductor muscles, one towards each end of the shell. The valves are hinged together by a band of soft horny material which, but for the pulling action of the adductors, would cause them to gape apart. To give greater stability and security to the closed valves, there is just below the horny hinge a more or less intricate series of ridges and depressions in the solid material of one valve which fit with wonderful accuracy into corresponding ridges and depressions on the other valve.

Many of these bivalves live buried in sand or mud, into which they are pulled by the action of the muscular foot; some, however, attach themselves to rocks by tough threads (byssus) spun by the foot. A familiar example is a crowded cluster of mussels on the wooden piles of a seaside pier.

like ascidians coating the submerged rocks. Similarly delicate but much smaller shells are those of the butterflies of the sea, so called, quaint molluscs that float on the surface and feed upon the minute life (plankton) there so abundant, though mostly invisible to our eyes. These sea-butterflies (*Pteropoda*), in their turn, form a considerable part of the food which nourishes some of the very largest whales.

Great beauty is displayed by many of these bivalves, either in sculpture or colouring, or both in the same individual, according to the demands of their life. Others, like the big pearl-oyster, which converts intrusive rubbish into precious gems, have their shells richly ornamented within, but may be commonplace or even squalid-looking outside.

Chapter LXXX

Animal Hands and Feet

How the Animals got them and What They did with Them

By T. H. Gillespie

Director of the Zoological Park, Edinburgh

To find the origin of feet and hands one must look back for a good many million years to a time when a new kind of animal had just come into existence. It was designed on a new plan, and it had a continuous chord of nerve matter extending the length of its body and the rudiments of a skull and brain, and it was the highest form life had yet attained—a primitive fish form.

Those earliest fishes were of simple elongate form with little about them to suggest the great destiny awaiting their descendants, and their eel-like progress through the water was aided by an expansion of skin running along the back and round under the tail. Soon, in some forms, this continuous middle fin was, it seems probable, supplemented by a similar expansion of skin on each side to help to keep the body upright in the water, something after the fashion of the bilge keels in the hulls of ships.

As need for increased power and speed was felt it appears to have been advantageous that these continuous fins should be broken up, parts of them being suppressed and the fragments remaining becoming larger and stronger and being reinforced by numerous rays, or rods of cartilage. Of the central fin several portions were retained, the most important being the tail fin, the fish's propeller. Of the lateral, or side fins only two fragments were retained on each side, forming two pairs of paddle-like fins. These were Nature's first rough sketch of what were eventually to become hands and feet.

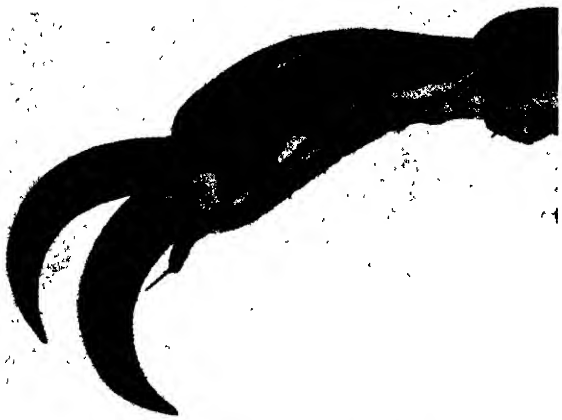
W. S. Berridge

APE WHOSE FEET ARE HANDS

Look at this orang utan clinging to a sapling. The feet are supporting it below as efficiently as its hands are holding it above. One hand is visible with its back and knuckles towards the camera while the other is above the animal's head, and out of the photograph

Doubtless these paired fins were very useful to their owners in balancing and steering, which were probably the needs that stimulated their production, though one might imagine that the swimming fish could have got along without them. Their greater importance began when some enterprising and adventurous fishes, pursuing their prey in the shallows, ventured to continue to hunt on to the wet mud or sand. Then the two pairs of side fins, pressing on the mud, became indispensable for maintaining an "even keel," and as more and more stress was laid on them they became gradually stronger and better able to support the body and assist its flopping mode of travel. To this day there are fish such as, for example, the mud-skippers and climbing perch, which habitually leave the water and use their strong pectoral, or breast fins in travelling over mud flats or climbing rocks or even trees, and we may see in them, perhaps, some suggestion of the manner in which the ancestors of the higher animals—reptiles, birds, mammals—first stepped ashore.

There was, however, a very long road to travel from such fins



H. Bastin

FEET AS EVOLVED BY THE BEETLE AND THE CRICKET
Here is a horned chafer beetle from East Africa (bottom) with its leg stretched out Above are enlarged photographs of (left) the claw or foot of a goliath beetle and (right) the fore-leg of a mole-cricket. The toothed "foot" works with the next joint like scissors to cut a way through the roots of turf in which the insect burrows.

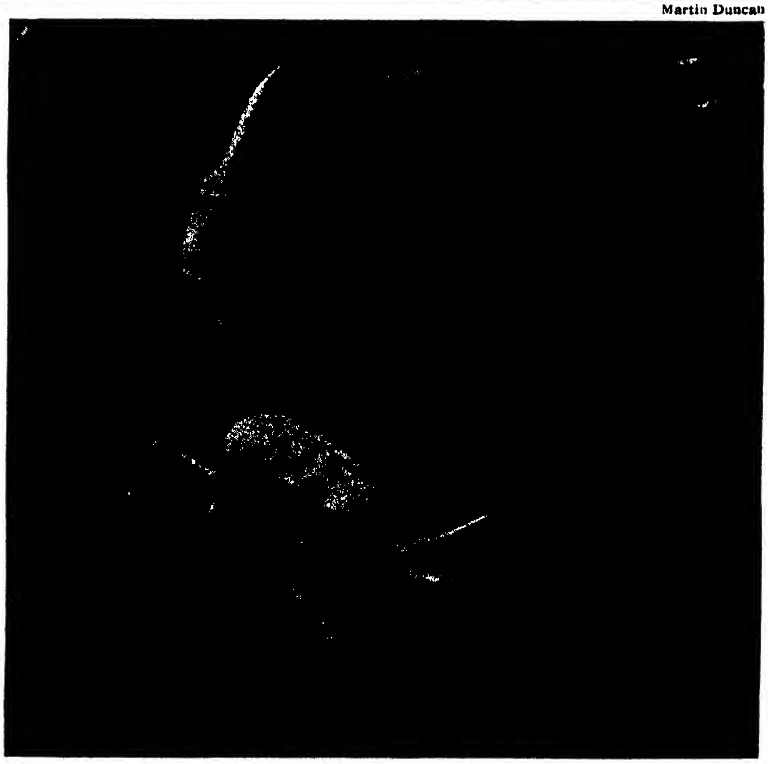
to the limbs of even the most primitive four-footed land animal. Gradually, as more and more strain was laid on the paired fins, they would respond with increasing strength; the rods supporting them would, by fusion one with another, become stronger and harder as they became fewer in number; then the need for flexibility in the thickening and hardening rods would lead to the formation of articulated joints. It is probable that even before the ascending types had passed from the fish stage the paired fins had acquired something of the form of limbs, with a jointed shaft connected to the body skeleton by incipient shoulder (pectoral) and thigh (pelvic) girdles, and having at their lower ends the fin rays, much reduced in number, shortened, strengthened, and hinged or jointed.

As the earlier fish-amphibian forms came into being the number of fin rays or, as we ought now to begin to call them, digits or toes, were reduced to, perhaps, eight, then to seven or six, and ultimately, by the time the amphibians (represented to-day by salamanders, frogs, and so on) were definitely established, their toes or digits had been brought to what was evidently to be a standardised number of five on each foot. Yet to this day human beings are sometimes born with six toes or fingers, showing, perhaps, the persistence of the age-old inheritance.

Nature, however, has the itch of experiment and, having produced this standard five-toed foot, immediately began to modify and alter it. In a general way one might say that there was underlying much of the ensuing alterations the idea that four feet and twenty toes were superabundant for locomotion alone and that some of them might be put to better use. Among the amphibians such modifications as occurred were not particularly exciting or interesting; they took the general line of mere suppression of some of the digits or even of the entire limbs. Some of these creatures, indeed, reverted to an entirely aquatic life and re-acquired the long body, with flattened tail and expansions of skin for swimming, with a strong resemblance in form to their fish ancestors.

NATURE, having brought her new backboned animals ashore by the medium of the amphibians, seems to have regarded that class as of little further account, and from some early salamander-like amphibian she very soon produced another new kind of animal—the reptiles. It was when the reptiles had become established that more important changes in the form and use of the limbs began to appear. The fashion, so far, had been to use all four feet for

Martin Duncan

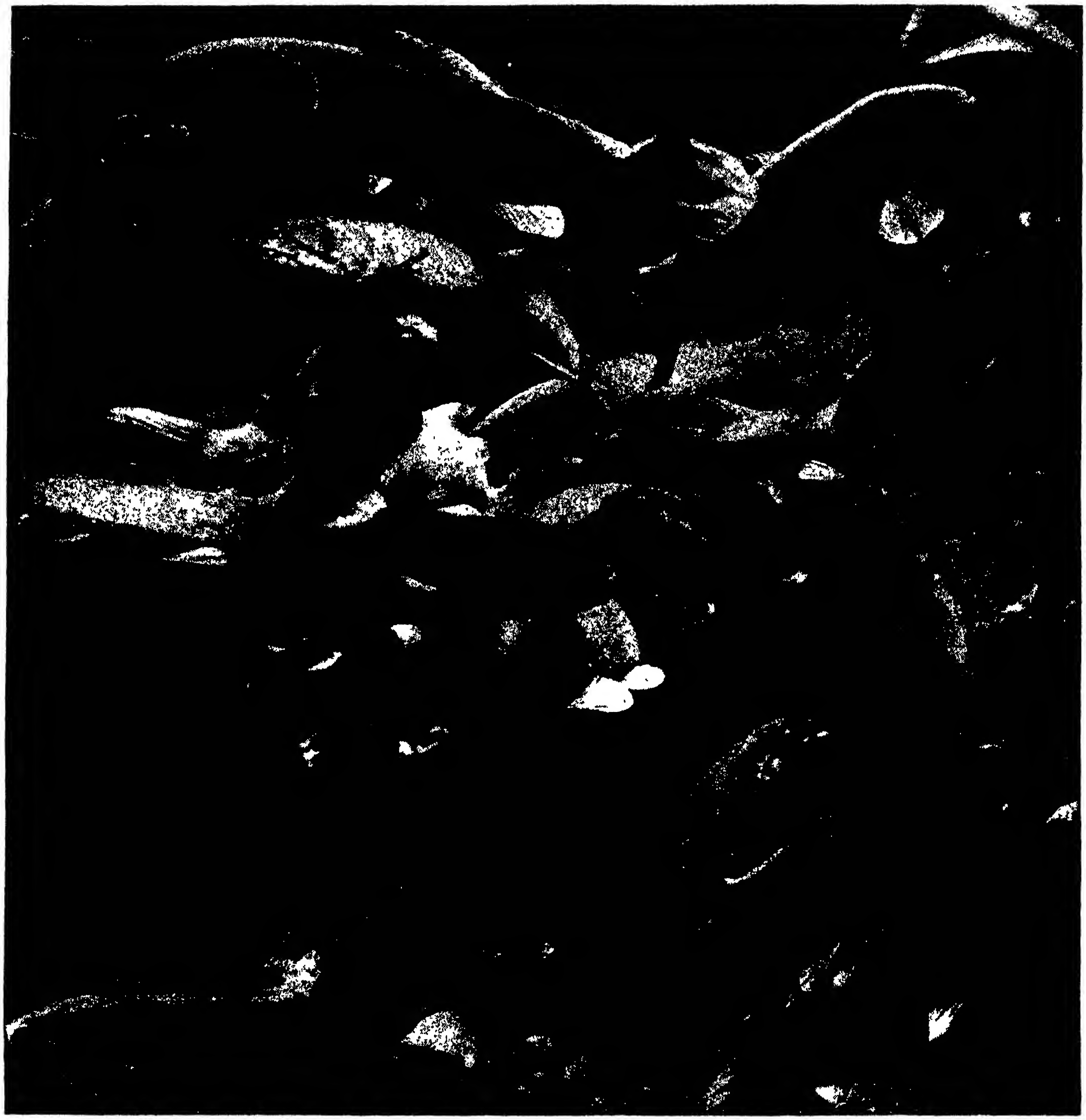


STRONGLY GRIPPING CLAWS OF CRAB AND LOBSTER

In the lower photograph a land crab in the London Zoo is demonstrating its gripping power by supporting its entire weight with one limb. The top photograph displays two squat lobsters with ugly-looking barbed claws. On the left we have a view from above and on the right we see the underside.

walking, though even among the amphibians the forefeet may have been used to assist in getting food into the mouth, as one may see in the case of present-day newts and frogs.

Some of the old reptiles went much further than this, for they learnt to sit up on their hind legs and hold their food with their forefeet. As the use of their forefeet in this way developed and more of the burden of carrying the body was thrown on the hind legs, the latter became relatively longer and stronger until, in some groups, the forelimbs probably ceased to be of any but the slightest use for locomotion, and these creatures walked or hopped on their hind legs. One has only to look at a squirrel nibbling a nut or a kangaroo crossing a paddock to realize something of the appearance of those old reptiles and the way in which they used their front feet. That was a quite definite attempt to make a real hand, but, having got so far, it never attained complete success and the reptile forms in which it appeared became extinct. No living reptile uses its forefeet in such a manner, though it is interesting to notice that several species of lizards which, in the



Shepstone

PRIMITIVE FORMS OF HAND AND FOOT: A CLUSTER OF BOWFINS

Clearly seen through the glass plate of their tank in the aquarium this cluster of moving fish which swim under and over each other in a welter of tails and fins and lithe, wet bodies displays to us the early beginnings of the hand and the foot. The origin of hands and feet goes back to the time of an eel-like sea creature which had the rudiments of a skull and brain. Its movement through the water was aided by an expansion of skin running along the back The bowfin still has a long fin something like the one possessed by that ancestor

ordinary case run on all four feet, will at times, especially when travelling for some distance over level ground, rise on their hind legs and run on two feet, the weight of the body being counterbalanced by the long and heavy tail.

In another branch of the reptiles was tried the experiment of adapting the forelimbs for use in an entirely new and very important direction—they turned their hands into wings and acquired the power of true flight. The wings of these flying reptiles were formed of a skin, or membrane, and to outstretch and support it the fourth finger of each forelimb became enormously lengthened, and to the group was given the name "pterodactyl" (wing-fingered) The skin, or membrane was continued to the hind legs and tail, but the toes of the hind feet and the remaining fingers of the forelimbs remained free and capable of independent action. This was a great achievement, but even with the advantages that flight affords, these flying reptiles failed to hold their place and gradually

Shepstone

HORSE MACKEREL AND RAINBOW TROUT AND THEIR FORMS OF FIN

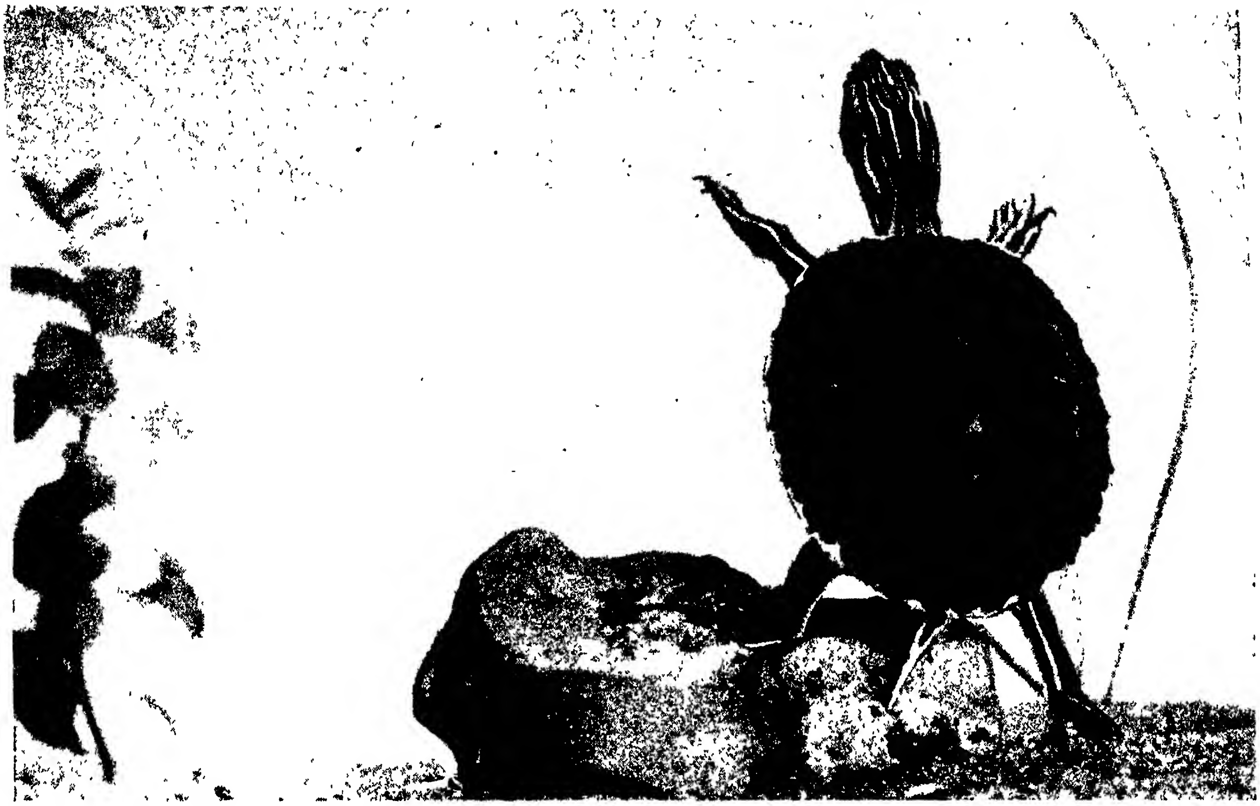
While the hand and foot began their course of evolution in the sea and ended on the land, certain forms of life, the fish, retained these primitive forms of hands and feet, different species developing their fins in different ways. Compare the fins of these horse mackerel (bottom) which live in the sea, to those of the fresh-water rainbow trout (top). The lower photograph was taken by F. Schensky and is from "Animal and Plant Life in the North Sea," which is published by the Biological Station at Heligoland.

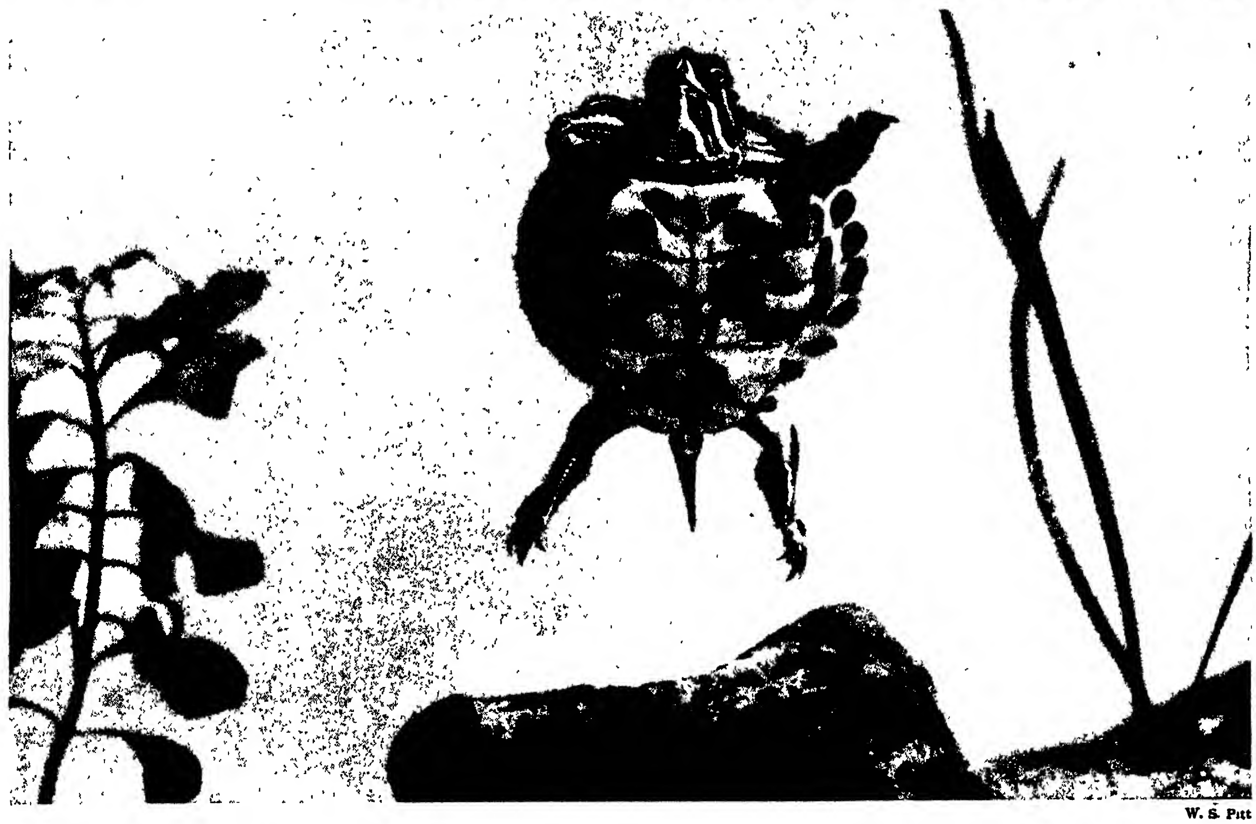
Otho Webb

W. S. Berridge

HANDS AND FEET AS DEVELOPED IN THE GREEN AND SMOOTH-CLAWED FROGS

As the earlier kinds of fish-amphibian forms came into existence during the course of evolution, the number of rays on the fins, which were the beginnings of what in later animals we call digits, or fingers and toes, was reduced to eight or six. By the time that the true amphibians, represented to-day by the frogs, had been evolved, the number of digits had become standardised by Nature to five to each foot or hand. Here are two examples of the primitive hand in the smooth-clawed (bottom) and green (top) frogs.

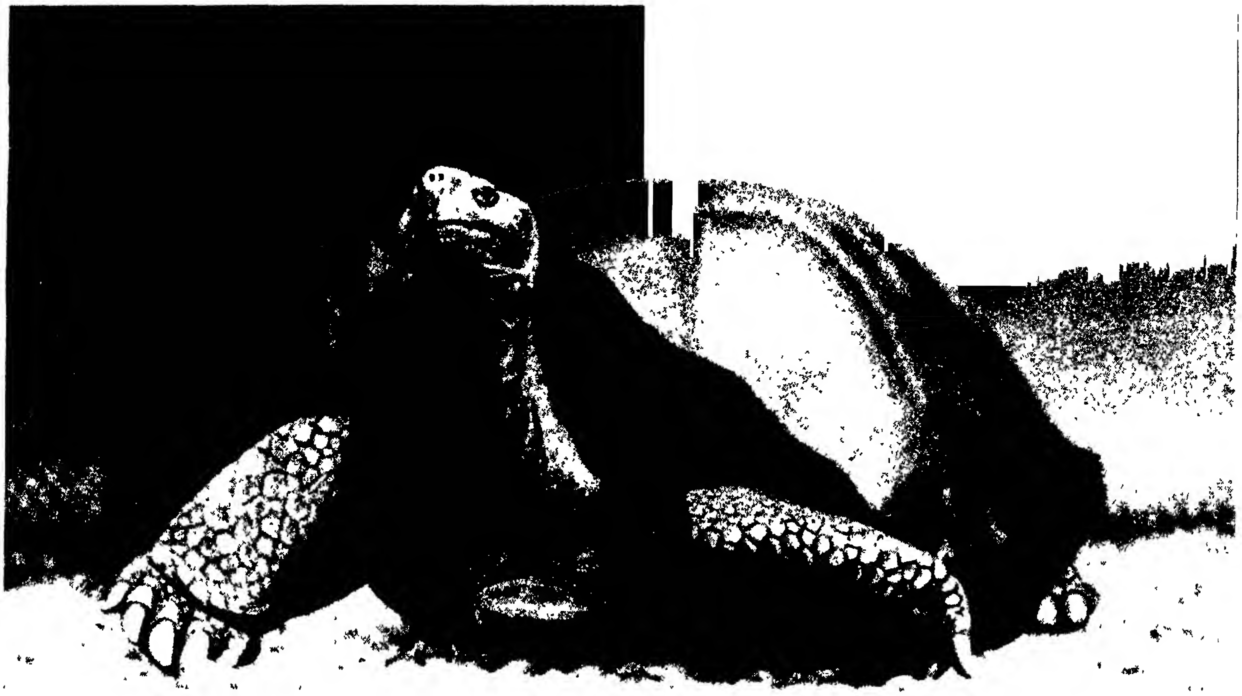


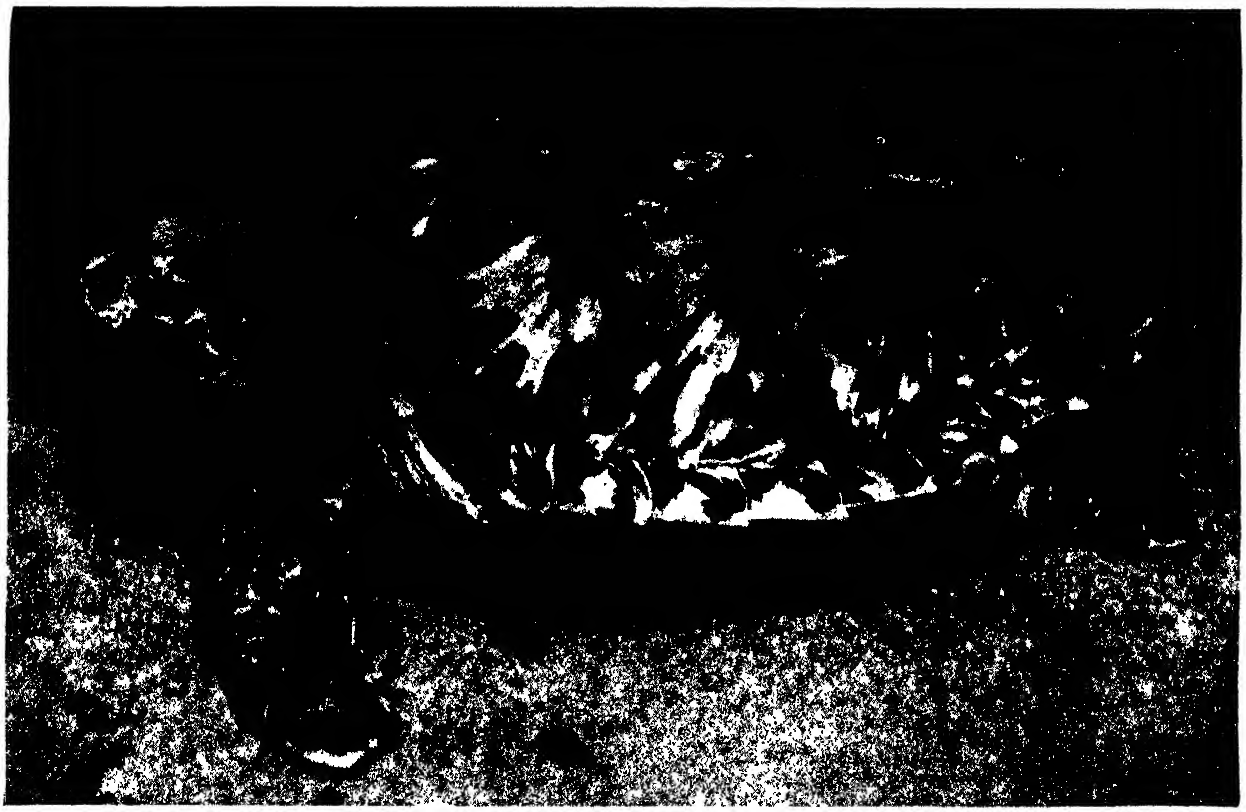


W. S. Pitt

CLAWED HANDS AND FEET OF THE GEOGRAPHIC TERRAPIN OF NORTH AMERICA

Geographic terrapins are natives of North America and live in fresh water. Here we see another type of hand with the digits developed but with no power of gripping in them. Their use is for swimming and crawling. The geographic terrapin is remarkable for the variations in the marking of the under-shell, no two specimens being quite alike in this respect. The attitude of the one in the lower photograph, which was taken under water, is rather reminiscent of a "levitation" as pictured by one of the old religious painters.





W. S Berridge

CLAWED TOES OF THE HAWKSBILL TURTLE AND GALAPAGOS TORTOISE

With the flipper of the hawksbill turtle we have a kind of half-way-house on the road of development from fin to leg and foot. The "feet," if they may be so described, merge imperceptibly into the "legs." The hawksbill turtle is the chief source of tortoiseshell, but useless as food. In the Galapagos tortoise (top) we see strongly-clawed feet and the legs still retaining the scales inherited from the early finned animals of the primeval seas. Indeed, these limbs seem better adapted for swimming than walking.

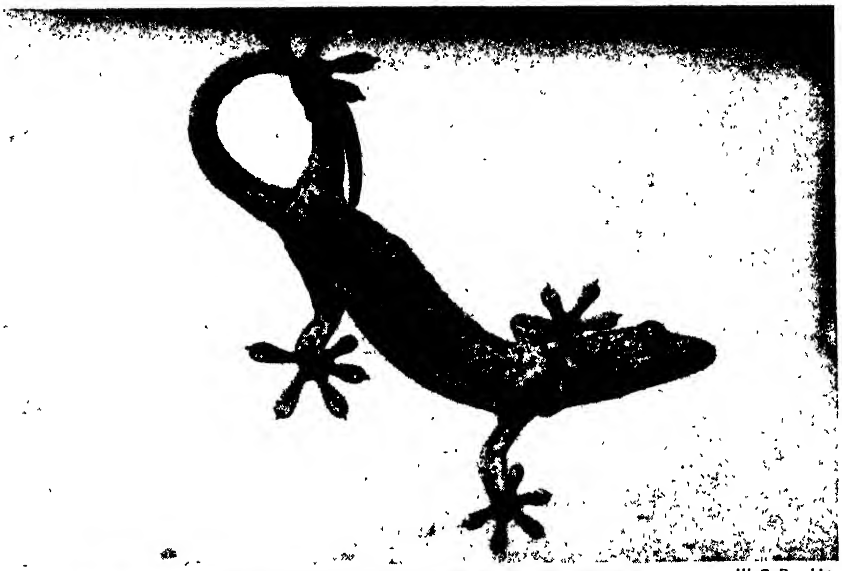
died out. That two such promising adventures should end in failure may have been due, in part, to limitations of the reptilian body and brain.

So far all animals had been "cold-blooded," that is to say, they were unable to sustain a temperature of body above that of the air or water surrounding them, and they had been covered with skin alone or with skin defended by scales or horny or bony plates. Long before the age of reptiles had reached its zenith, however, a new experiment of a most revolutionary kind had been proceeding and new types were now evolving with improvements in heart, lungs, and circulation of blood, bringing the capacity to maintain a constant temperature of body independent of that of its surroundings. With this capacity came greater potentialities of adaptation of body and growth of mind. To conserve this temperature something more heat-retaining than skin or scales was required to cover the body, and there appeared in due time the hair-covered mammal and the feather-covered bird.

The birds converted their forelimbs into organs of flight, but far more efficient ones than those of the flying reptile because they were driven by a better engine, and this entailed a greater change in the structure of the limbs so that, in order to give the fullest support to the flight feathers of the wing, the bones of the fingers became more or less fused together.

By turning their hands into wings of such an efficient kind the birds were made masters of a new world, the air; they could travel for distances and at a speed that nothing running on the ground could dream of and they had thus greatly enlarged powers of obtaining food and of escaping dangers. So they have held their own and have become the most varied and, perhaps, the most numerous class of animals.

Some groups of birds fell aside in the race, and either never attained complete ability to fly, or, if they did so, they afterwards lost it. Living examples of such birds are the penguins, in which the wings have been turned into paddles or flippers—wonderfully efficient for swimming but utterly useless for

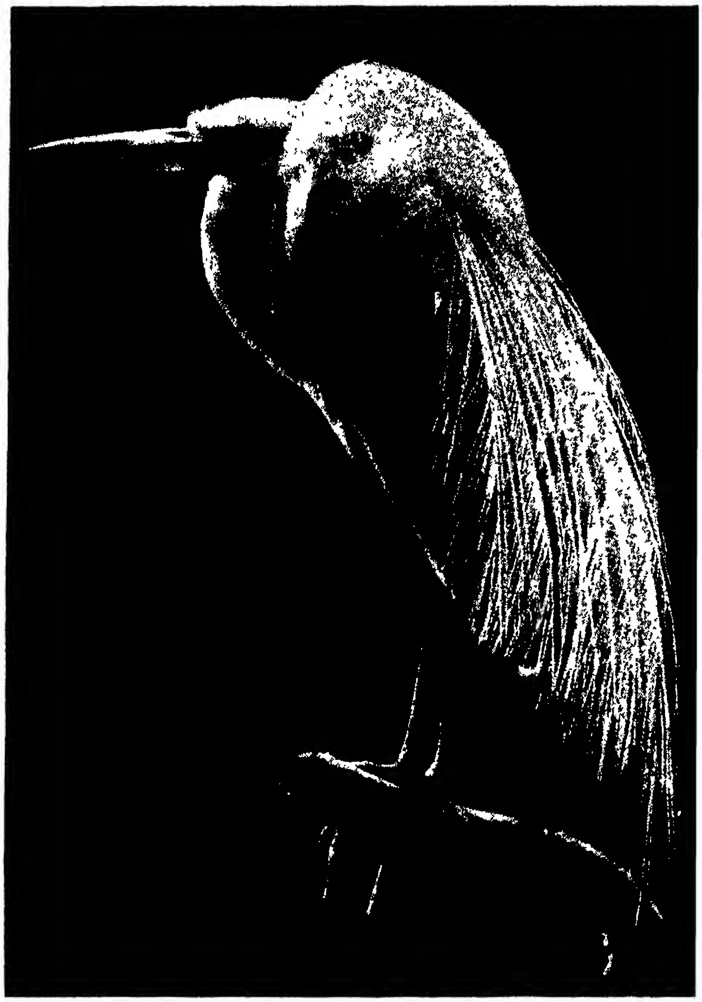


W. S. Berridge

M. H. Crawford

A GREEN LIZARD AND AN INDIAN GECKO

This green lizard (bottom) comes from the Channel Islands and its general shape reminds us of those huge dinosaurs that were the limit of development, so far as size was concerned, made by the reptilian forms of life. Above is a verticellated gecko from India. Its feet are very interesting, their shape being rather like that of some cactus plant.



THE CLAWS OF THE PERCHING HERON
When perched the heron's claws are seen to the best advantage. They are very long and powerful and the nails look really formidable. Notice that the claws to the front hang a long way below the perch. This is a white heron, or egret, yielder of the famous plumes used in millinery.

flying—and the ostrich group in which the wings are quite feeble and serve little apparent purpose save that of ornament.

The hind limbs of the birds remained constant to their original duty of carrying the body, but since the forelimbs were entirely cut off from any hope of functioning as a hand we find that there is among birds a distinct tendency to use the feet for this purpose; among parrots, for example, one may see quite small objects readily held in the foot. In the feet of birds many very interesting changes and adaptations have occurred

In the first place, the several bones which originally formed the foot have become fused together and lengthened, and so what many people regard as the bird's leg, that is the scaly part (reminiscent of its reptile ancestors) which reaches from the toes to the joint (the ankle) where the feathers usually begin, is, in a sense, its foot, and the bird stands and walks on its toes. The toes are never more than four, the fifth having been lost, and in most birds they are arranged three towards the front of the leg and the fourth (which corresponds to the first, or great toe of our own feet) projects behind. In the perching birds and the birds of prey this hind toe is as strong as the others and of great importance since the grasping power of the foot depends on it, but in some groups, such as the swimming and the running birds, it is reduced in size and useless, and in some it is absent altogether.

In the perching birds the tendons which bend the toes are so arranged that when the ankle joint is bent the muscles that contract the toes are tightened and the toes drawn together. By this means, when the bird settles down on its perch the toes grip it without any muscular effort, and the more sleepy the bird is and the more heavily its body presses downwards the firmer is the grip, and so the bird sleeps in safety without fear of falling. In the eagles and falcons the gripping power of the toes is amazing, and these birds seize and hold their prey with their feet, the long, sharp claws with which the toes are armed adding to their efficiency. In these birds the first, or hind toe is of great importance, and a falcon's ability to gain his living is much reduced if any accident should deprive him of a hind claw. Then the swimming birds have altered their feet by connecting the toes with a webbing, or membrane, so that the foot acts as a paddle. Most of the swimming birds, even those that dive and swim below water, such as cormorants and gannets, have kept their wings in good order for flying, the penguins being the only group of aquatic birds that are incapable of flight, and they also have the toes webbed, though their feet are not used in swimming.

Most interesting is the change that has taken place in the foot of the ostrich. This bird, utterly incapable of flying, depends entirely on speed of foot for safety. The call for speed has led to great development in the length and strength of the legs, but it has done something more. It is clear that Nature places more reliance on one strong organ than on the cumulate strength of several weaker ones, and so we find that the ostrich, having to carry a heavy body far and fast, has reduced its toes to two on each foot, and not only so but that it seems in process of getting rid of two of those that remain, for one toe on each foot is much smaller and weaker than the other, and does little more than touch the ground, and almost the whole weight of the bird is carried on two very strong toes. A similar modification has taken place in the foot of the ostrich as that undergone by the feet of the horse, though in the bird it has not yet proceeded quite so far along the path of evolution

HANDS AND FEET AS DEVELOPED BY THE GEOGRAPHIC TERRAPIN

This brightly coloured terrapin of North America uses its hands and feet not only for swimming but also for crawling. The digits, or toes an fingers, are therefore provided with claws. Nature has been particularly busy with subtle modifications of the hands and feet of the chelonian to which order the terrapins belong. The geographic terrapins have beautifully and very variously marked undershells

To face page 888

Now we come to the mammals, the most interesting class of all since we ourselves belong to it, and it includes the widest diversity of size, form, habit, and intelligence, of locomotion and of feet; moreover, it is among the mammals that the age-long effort to produce a true hand finally reached its fulfilment.

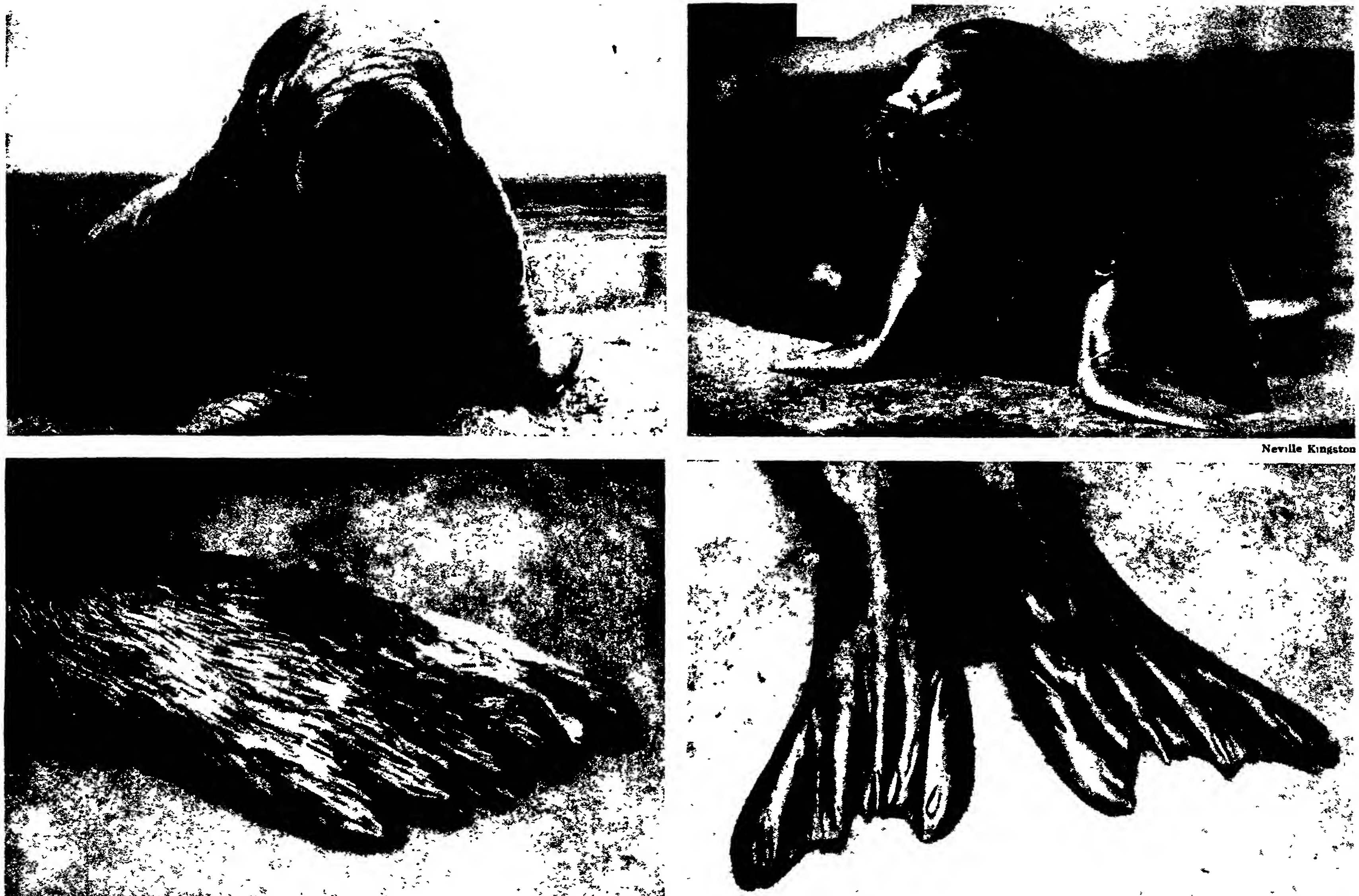
The mammals are descended from some reptile stock of generalised type, perhaps from something very near the amphibian; at any rate, they evidently inherited the full complement of five toes to each foot. They soon began to possess the earth, and as they increased in number and competition became keener they adopted a multiplicity of ways of gaining a living with equally numerous related adaptations of form. Some of the paths they chose show a strong resemblance to those followed by the reptiles. One of the most primitive types still existing, the kangaroos, have very long and strong hind legs on which they travel by leaping instead of running, and diminutive forelegs which are used chiefly for holding food or grasping, and in these respects they recall what one knows of the old bi-pedal dinosaurs. The mammals also made a bid for a place in the air and the flying pterodactyls are paralelled by the ancient family of the bats. In turning their forefeet, or hands into wings the bats have retained the full number of fingers but excepting the thumb, which is of moderate length, the finger bones are all exceedingly long and slender, and support a delicate membrane which stretches along the arm, over the fingers, and back to the hind leg. The thumb is free and has a sharp claw, and is used by the bat in climbing and to hang himself up when he goes to sleep. The wings of the bat and the flying reptile have a much stronger resemblance to each other than either has to the wing of a bird. Then, just as some of the early reptiles returned to the sea, turned their legs into paddles and even acquired an almost fish-like form, so several quite distinct mammals have done the same. The whales are descended from land mammals with four feet, yet now they have the spindle-shaped body so suited for easy travel through water, their hind limbs have disappeared except for mere vestiges, and the forelimbs are turned into flippers, though they retain in most cases the same bones and joints as other mammals, and five fingers.

YELLOW-CROWNED PENGUIN'S FLIPPER ARMS

Birds having turned what were once fore-legs into wings, some of them, like the penguins, have gone through yet another transformation and made their wings into flippers for swimming. This yellow-crowned penguin of New Zealand has clawed feet and very thick "ankles"

Then there are the sea-cows (*Sirenia*), which, though unrelated to the whales—their nearest relatives alive to-day are probably the elephants—have undergone a similar change of form and of limb. The elephants themselves, though in many respects among the most specialised of mammals, have been very conservative in regard to their feet; they have retained the general form and arrangement of the bones and they have not lost a single toe, though, as the bones of the toes are comparatively short and very massive in proportion to their length, as befits the great weight they have to carry, they do not show externally except by the five hoof-like nails.

There have been among mammals three important branches or lines of evolution—the herbivorous or grass-eating animals, the flesh-eaters, and a branch which, refraining from over-specialisation and holding a nice balance of potentialities, placed their hope of survival in adaptability and a growing brain, and so led through humble lemur and monkey-like forms up to man. The life habits of the grass-eaters tended towards the pacific. They might have, and indeed some of them did, acquire such an equipment of strength and of defence as to make even the fiercest beast of prey respect them, but the tendency of most



Neville Kingston

W. S. Berridge

SEAL, SEA-ELEPHANT AND WALRUS AND THE STRUCTURE OF THEIR SPECIALLY ADAPTED LIMBS

In the true seals, which are the descendants of land carnivores which have betaken themselves to the sea for a living, the change from foot to flipper has gone a long way. The fore limbs (bottom left) have the toes webbed, but have retained strong claws. But the back limbs (bottom right), have become quite useless for walking and are permanently directed backwards, being of use only in the water. The sea-elephant or elephant seal (top left) has the same characteristics as regards its limbs while the walrus (top right) has its hind limbs turned forward beneath the body. We see the animal here scrambling out of its swimming pool at a zoological garden and displaying its clawed fore-flippers.

of them was to evade danger by fleeing from it. So, in the evolution of their limbs, everything was sacrificed to speed. They rose on their toes—everyone has to do that in running—the bones of the thigh and upper arm became so overlaid with muscles and flesh that they are almost merged in the body, and so the knee and elbow joints are almost hidden, and what we call the knee of a horse is really its wrist, while the prominent joint on the hind leg (hock) is really the ankle. The long bones (called the cannon bones) beneath the horse's " knee " and hock correspond to the bones of the palm of our hand and our instep; but instead of having several bones side by side as we have, the horse has got rid of all but the centre one, which is of great thickness. The horse has also lost all his toes and fingers except the middle one on each foot, which, like the bone above it, is immensely strengthened. Moreover, the horse walks almost on the end of his toe, and to protect it the nail has grown into a kind of horny box which we call the hoof and protect further with a steel shoe.

E.N.A

ELEPHANT'S FOOT AND ITS NAILS

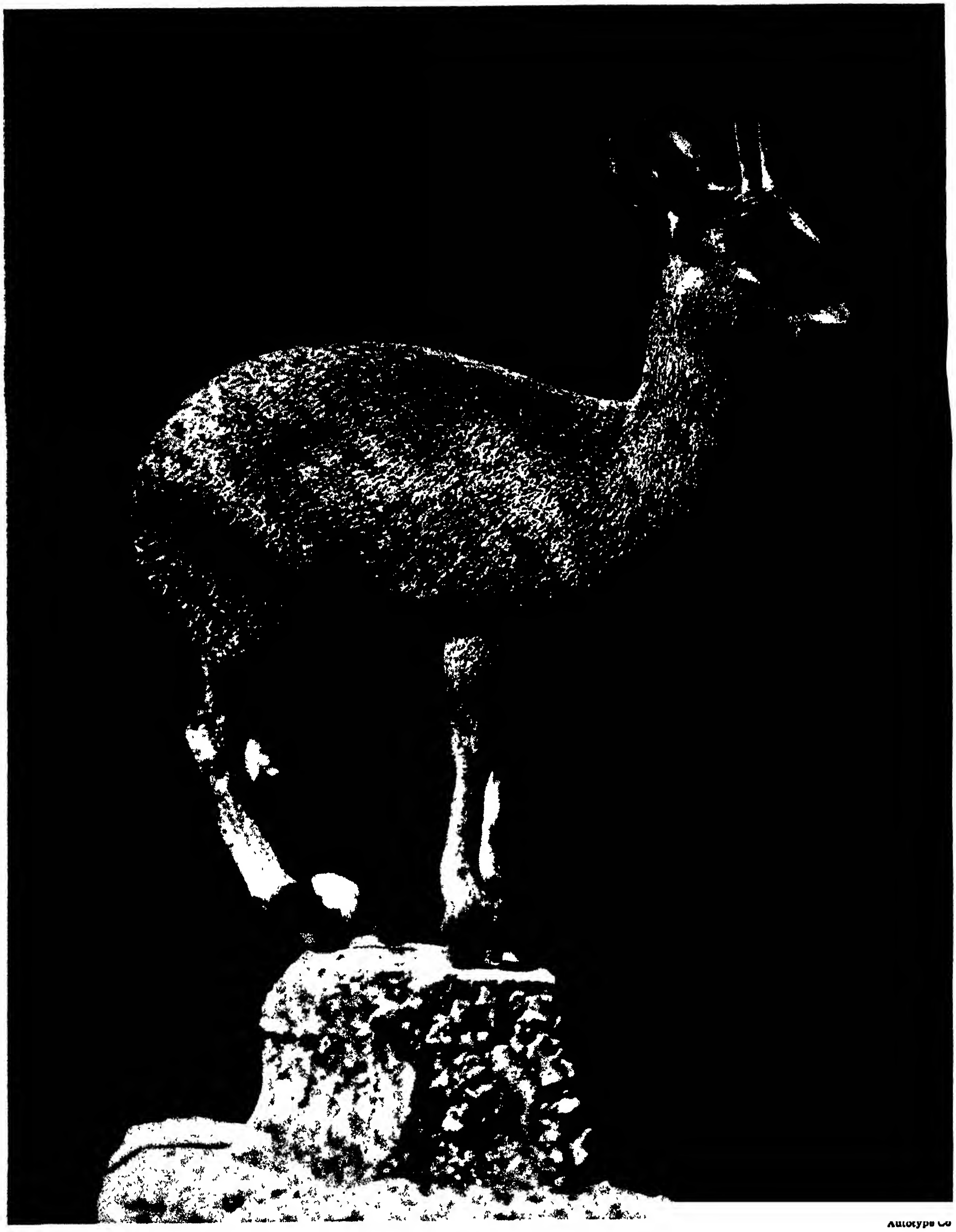
Below we have a remarkable photograph of an elephant's foot, taken from beneath. The toes are so short that they do not, save for the nails, protrude through the flesh. Above is an elephant in the Bronx Park Zoo, U.S.A., having its nails filed.

F. W. Bond

K N A

GORILLA, BABOON AND CHIMPANZEE USING THEIR HANDS

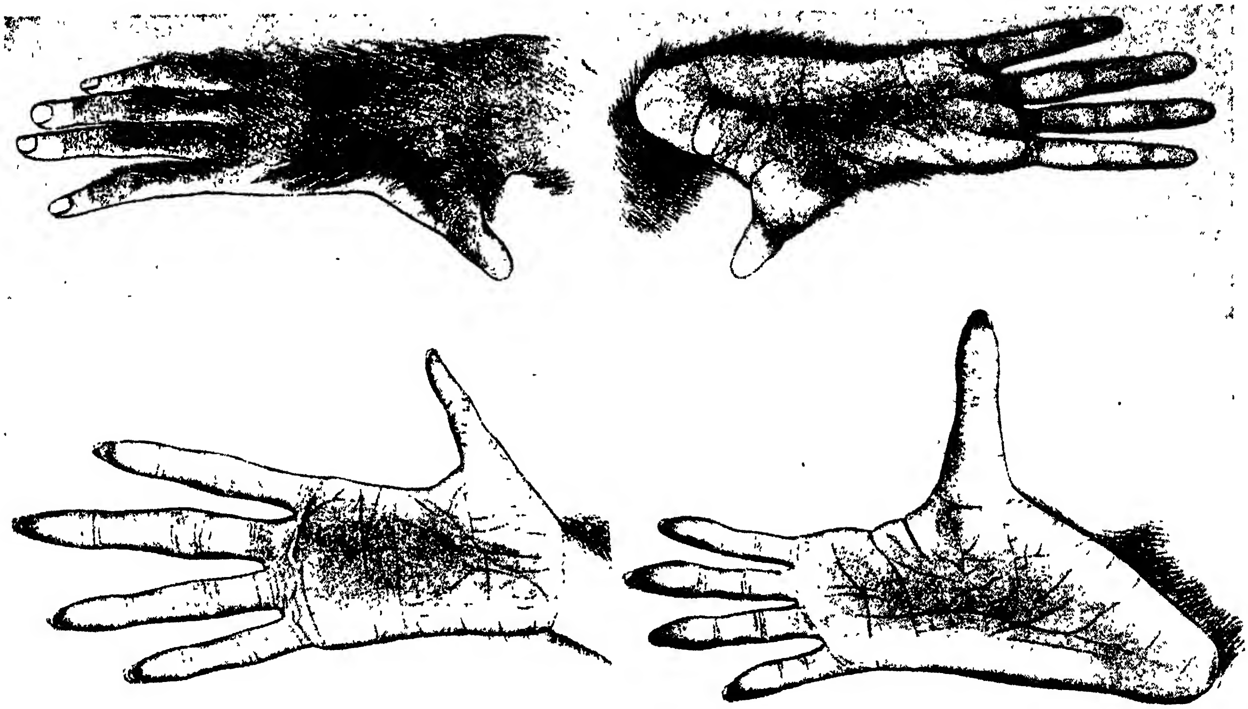
When, in considering the scale of evolution, we have got as high as the monkeys, we find that we have got very near to the true hand. The birds started the process by turning round one of the digits of the hind limbs so that its action could be opposed by the others thus enabling a grip to be taken. Not all monkeys have a thumb, but most of the Old World monkeys have one. Here are examples of the uses of monkey hands, the gorilla, for instance (bottom left), in walking and the mother baboon (bottom right) in carrying.



Autotype Co

WONDERFUL AND MINUTE HOOFS OF THE LITTLE KLIPSPRINGER

The name of this little antelope which lives in East Africa is klipspringer, and this signifies "rock-jumper," for it has an amazing power of jumping from crag to crag. The hoofs are so small that if all four are placed together they can stand on a five-shilling piece. The antelopes, along with goats and deer and pigs, have discarded all but two of their toes for practical use, and the hoofs are really the nails of these toes. In some cases the remnants of two other toes can be seen.



London Zoological Society

MONKEY HANDS AND FEET IN DETAIL: CHIMPANZEE AND ORANG UTAN

These hands and feet show the development attained by the chimpanzee and orang utan. The left-hand bottom photograph is of the hand of a chimpanzee and shows the large palm and fingers, and the comparatively small thumb, while the foot of the same animal (bottom right) shows the great toe developed like a thumb. The orang utan has a rather atrophied big toe as seen from the back (top left), while the other toes are long and the front view (top right) shows the palm-like surface of the foot.

A similar kind of change took place in other groups of grass-eaters—the cattle, antelopes, sheep, goats, deer, camels, and swine—only instead of throwing away all but one toe they retained two on each foot of equal length, which, encased in the box-like nail-growth, are the "cloven" hoofs of these animals. In most of them the ends of two other toes can be seen, much reduced in size and covered by little hoofs which do not reach the ground.

In the flesh-eating group of mammals we find four kinds of foot. The bears, which are carnivorous more by relationship than by habit, since they live as much on vegetable food as on flesh, are conservative people who have kept to the old custom of walking on the soles of their feet, and the bones in a bear's foot correspond very closely with those of our own. In the more truly carnivorous animals of this group there has been a certain conflict of function—on the one hand a call for speed to catch the swift prey and on the other a need for grasping power to hold it when caught.

The seals and sea-lions are the descendants of land carnivores which have returned to the sea and have turned their paws into flippers. They have kept the full number of fingers and toes and have grown a strong webbing of skin between them. In the sea-lions the limbs still possess a considerable degree of freedom of movement, and a sea-lion can travel on land at a very respectable speed with a galloping motion. In the case of the seals proper, however, the change of foot into flipper has gone further; the hind limbs project behind and are useless except for swimming, and these animals can move on land only by a laboured, awkward shuffle.

In the monkey folk the true hand is drawing very near. The first step towards it was one already taken by the birds, the turning round of the first digit or thumb until it could be opposed to the remaining fingers and so enable the hand to close on an object. The monkeys, however, did not all do this; some living species indeed have lost their thumbs altogether and use their fingers chiefly as hooks with which to hang on to the branches of trees.

Ordinary monkeys still walk on all-fours, with their feet and hands flat on the ground; nevertheless, they are capable of grasping things in true hand fashion. The chimpanzees and other apes use their hands in walking on all-fours, but they usually do so by resting the back of the fingers or knuckles, not the palm of the hand, on the ground, and they often assume a stooping erect position resembling the attitude of a decrepit old man.

Last stage of all came man himself, of humble pedigree, with a foot not much better than a bear's, and a hand not so materially different from an ape's, but with upright carriage, hands set free completely from their former function as feet, and with the enlarged brain and growing mind that enabled him to use them to the utmost and to which, alone, he owes the supremacy which he has gradually attained over all other animals.

Chapter LXXXI

Masons and Builders on Land and Sea

By W. S. Berridge

Author of "Marvels of Natural History"

IN the study of animal life one cannot fail to notice how various creatures often display a tendency towards following some human vocation. Many of them, for instance, are expert trappers and hunters; some follow the unromantic but nevertheless useful occupation of a scavenger, while others, to which we propose to confine our remarks, are builders and masons which frequently exhibit such ingenuity in the construction of their homes that it is difficult to realize the work they accomplish is merely the outcome of instinct, and not of reasoning power.

Although the birds are the most familiar builders of the animal world, certain mammals, reptiles, amphibians, and invertebrates also follow the example of the feathered folk and make nests, the structures sometimes being very elaborate.

The gorilla, the chimpanzee, and the orang-utan build rough platforms of sticks amidst the branches of the trees, and upon these hard beds the females and young ones sleep, while the males take up their stations below so as to be ready to defend their families in case of need.

Some years back an adult orang utan at the London Zoo escaped from its cage after dark, and made its way into the grounds. The ape had spent the greater part of its life in captivity, and was accustomed to sleep in the quarters provided for that purpose, yet no sooner had it secured its liberty than it climbed to the top of a tree and proceeded to make a nest—an incident showing in a remarkable manner how retentive an instinct may be.

It is somewhat curious that, although the monkey family comprises such a vast and varied number of members, nest-building is only practised by those higher types already mentioned, and a few of the lower forms, as exemplified by certain species of mouse-lemurs and galagos, the arboreal homes of which are composed of twigs, leaves, and grasses, and sometimes lined with hair.

BUT closely allied to the lemurs is a creature, known as the aye-aye, which comes from Madagascar. It makes a large ball-shaped nest measuring about two feet across, the exterior consisting chiefly of the leaves of the traveller's tree, while the interior is bedded with small twigs, grass, and so on. The natives hold the creature in great dread, and refrain from molesting it. They believe it possesses the power to destroy those that seek to do it an injury, and should a man inadvertently catch one in a trap set for some other animal, he liberates the captive, after smearing fat over its body as a peace offering.

Of British mammals we have in the little harvest mouse an animal that has earned considerable fame for the beautiful nest it constructs. Attaining but one-sixth of an ounce in weight, and measuring only two inches in length (exclusive of its tail), this tiny creature weaves blades of grass and other material into a globular-shaped structure about the size of a cricket ball. Sometimes this is suspended from a twig, or it may repose in the head of a large thistle, but more frequently than otherwise it is bound to and supported by several stalks of growing corn. The nest only serves as a summer residence, and when the weather becomes chilly the mouse retires underground, where it remains in a torpid condition throughout the winter.

The common dormouse is another animal of our countryside that builds a nest, but instead of being content with one, it makes two, the first being utilised as a summer residence wherein the young are born and reared, and the other serving as winter quarters and a storehouse for food. These shelters, which are globular in shape and composed of leaves and moss, are built amidst hedges and bushes.

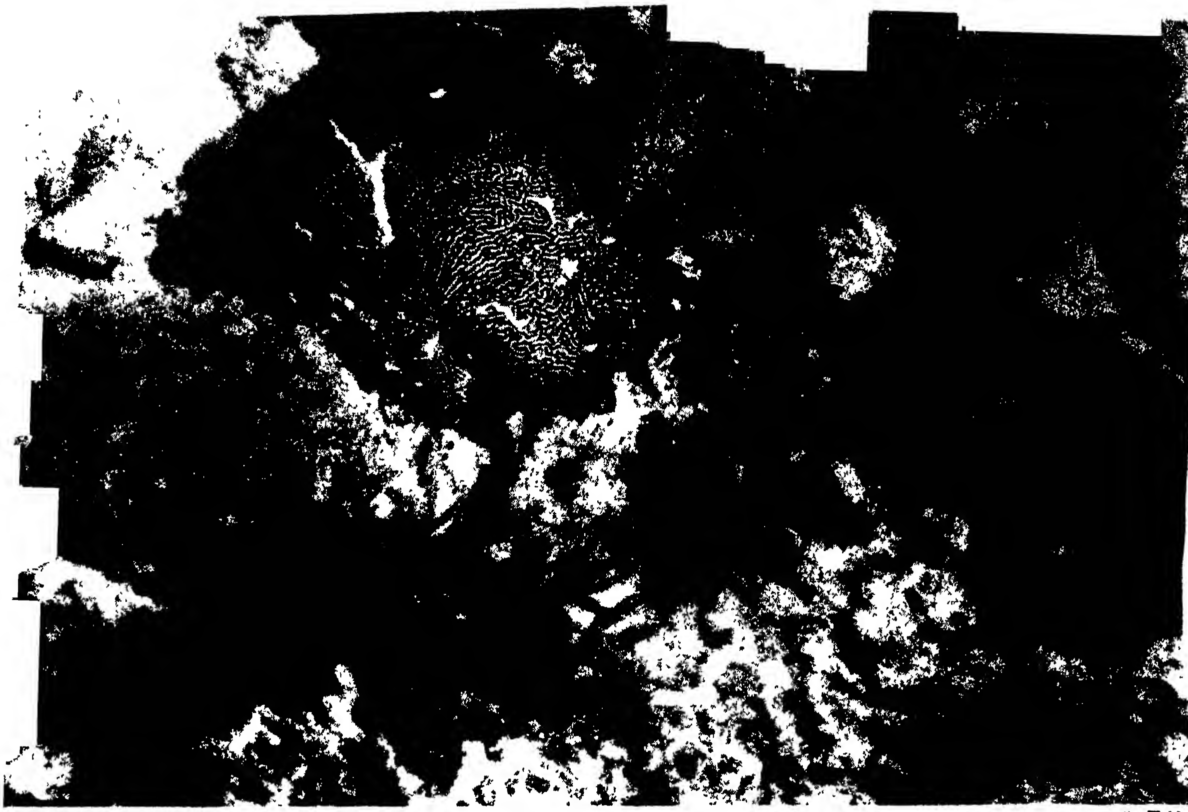
The European squirrel dormouse and the white-footed mouse are yet further examples of the diminutive nest-building rodents.

The former is an animal that used to be reared in captivity by the Romans for serving at their banquets, but the taste for such a dainty appears to have died out, and we very much doubt if nowadays even a Soho restaurant could produce such a dish should the request arise. The most likely place to find the creature would be in the cavity of an old tree, though sometimes it appropriates the deserted home of some other animal, patching it up and otherwise making it fit for its own habitation.

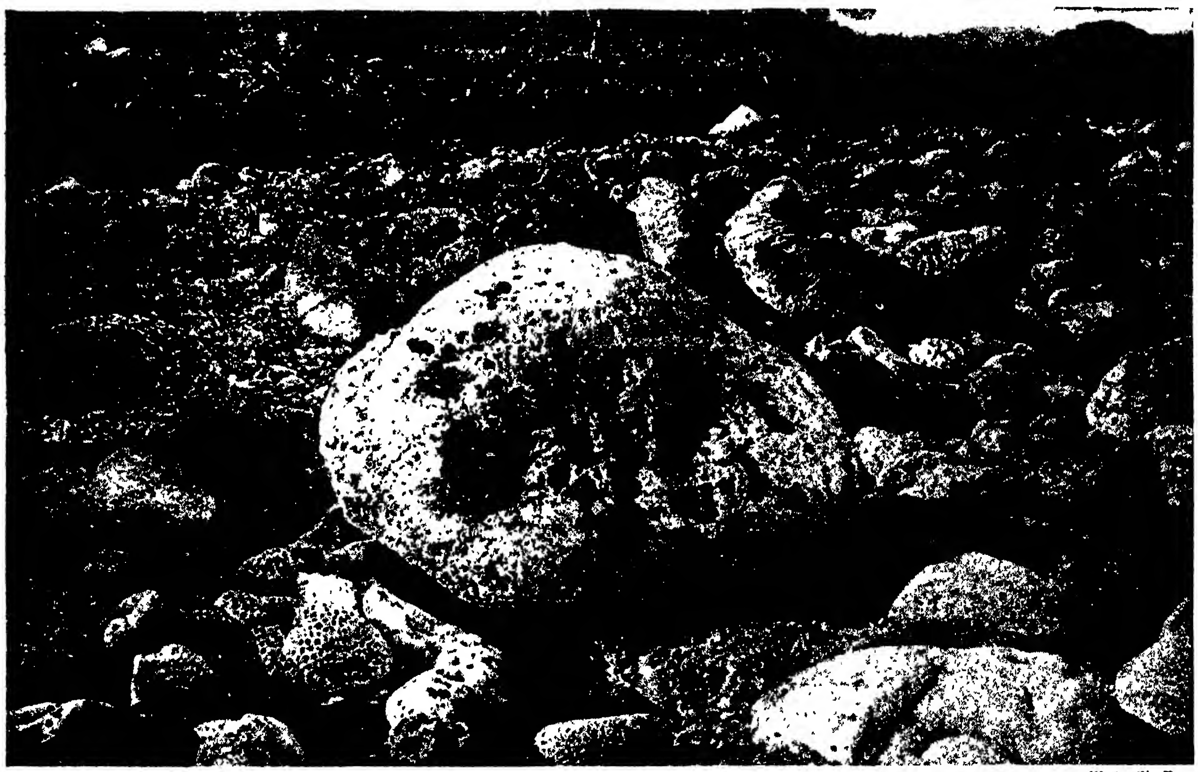
THE white-footed mouse, on the other hand, often builds its nest of moss and strips of bark, suspended from the branch of a tree, as much as fifteen feet above the level of the ground. Possibly it finds such a situation more bracing and more conducive to sleep than one at a lower elevation.

The building habits of the musk-rat, or musquash are of interest. It makes its headquarters in a burrow containing a large sleeping chamber, the entrance to which is situated beneath water. But often it will erect a special winter domicile composed of grass and weeds plastered together with mud, the foundation resting upon the bed of a stream or swamp, and the material being piled up so that the domed roof is well above the level of the water. This "hut" or "house," as it is called, is frequently of considerable size, and as the herbage with which it is built is of an edible nature, the residence serves both as food and shelter for the inmates.

The squirrels, the marmots, and the beavers are other rodents that make nests. Some of the former dwell in underground homes, but others, such as the British squirrel, build large arboreal shelters or "dreys"



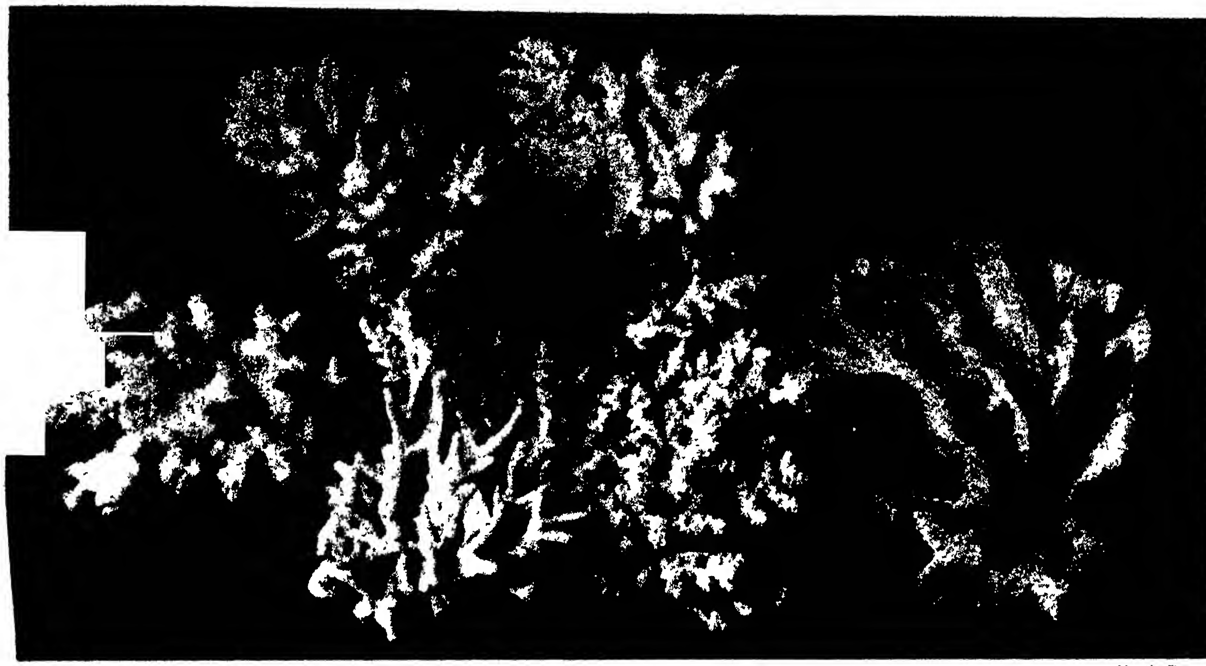
Otho Webb



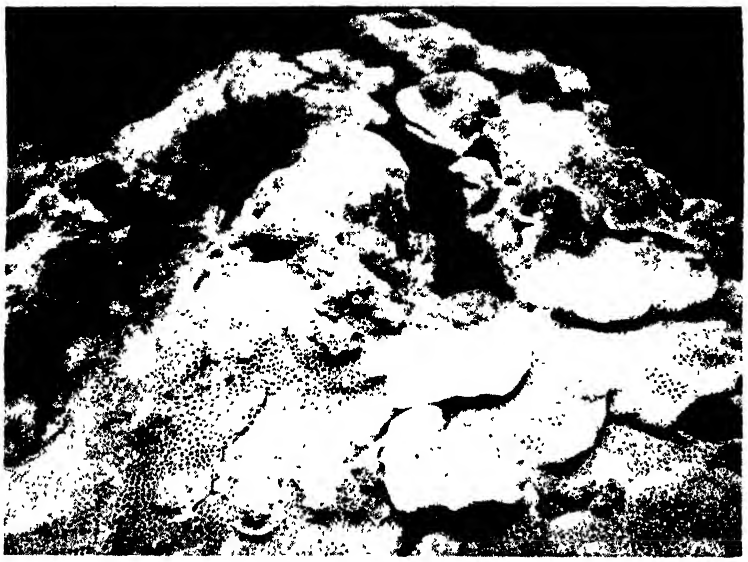
W. Saville Kent

COLONIES OF MINUTE SEA CREATURES THAT BUILD WONDERFUL HOMES

In the lower photograph we see a beach at Port Denison, Australia, which is covered with lumps of coral which have been broken from their parent reefs by storms and washed up by the waves. The damage done to the reefs whence these fragments come will soon be repaired by the wonderful little creatures which, out of carbonate of lime extracted from the sea water, fashion dwellings for themselves which exhibit all the hues of the rainbow. The top photograph shows the variety of coral that may be met with in a few square yards



Martin Duncan



W. S. Berridge

A CORAL "CLOSE-UP" AND SOME PLANT-LIKE FORMS

In the lower photograph there is a very close view of a piece of coral showing the surface built up, seemingly, in a series of layers, and pitted with a number of minute holes. The upper illustration shows a group of reef-forming corals whose forms are distinctly plant-like. The coral polyps build all this from the lime in the sea water.

composed of leaves, fibrous roots, moss or dead bracken. These have a domed roof, and the entrance is often made more attractive and weatherproof by the addition of a projecting eave.

The marmots all excavate underground burrows as a habitation, and vast areas of ground are often undermined to such an extent as to prove a source of danger to riders on horseback. Tunnelling with the aid of their forefeet, the animals loosen the soil and kick it backward so that it forms a cone-shaped pile around the entrance of the subterranean quarters. The ground thus heaped up not only serves to prevent the rain from flooding the home, but it also constitutes an elevated perch from which the animals can scan the surrounding country on the look-out for lurking foes.

It is, however, the work of the beavers that calls for special notice, for the constructive ability of these creatures is more highly developed than that of any other mammal, combining as it does the craft of mason, builder, and carpenter.

Although sometimes making a simple burrow in the bank of a stream for a habitation, more frequently than otherwise beavers erect in the midst of the water a large structure or "lodge" composed of twigs and branches, cut into suitable lengths with the aid of their chisel-like teeth, and held together with a plastering of mud. One or more compartments are situated within the lodge, and a bedding of wood-chips, leaves, and so on, is added to make the home comfortable. Access to the interior is obtained only through tunnels leading from below water.

But in addition to constructing these lodges, beavers will often erect a barrier or "dam" across a stream for the purpose of holding up the water and keeping it at an even level. Gnawing through and felling small trees, and collecting branches, sticks, roots and grasses, they carry or float this material to the desired position, weighing it down with stones, and cementing it together with mud so as to render it impervious. As a dam may measure

W. Saville Kent

LOWLY BUILDERS OF MIGHTY STRUCTURES IN THE OCEAN CORAL OF AUSTRALIAN WATERS

To the general public coral is an ornament. To the mariner it is often a deadly menace and many a good ship has lain with bleaching ribs on the deadly reefs of masonry which the coral polyps build up. To the naturalist these reefs wear quite a different aspect. They are to him an ever-expanding monument to the activities of a wonderful society of tiny creatures which build dwellings for themselves and, dying, leave their mansions, coloured like a flower bed in a garden, for the wonder and admiration of the men with eyes to appreciate them. It must be remembered that though coral is tremendously hard the coral polyps are soft and fragile creatures. Here we are on the wonderful Fringing Reef of Port Denison, Australia.

as much as two hundred feet in length, and be of considerable thickness at the base, one can well imagine the amount of labour expended in its erection.

It has often been stated that beavers employ their tails as a mason's trowel for the purpose of plastering the mud upon the face of their dams, but this is but one of the unnatural natural history stories that are continually being repeated, and has no foundation in fact, for the creatures merely use their fore-paws for that purpose.

No account of mammalian nest-builders would be complete without mentioning the mole. Its underground home or "fortress" is a very elaborate affair, consisting of a central chamber, bedded with grass and leaves, from which numerous galleries radiate in various directions. Some of these do not extend far, but that known as the "bolt" or "main run," which is of greater circumference than the others, is directed downwards from the central chamber, and then turns upwards and connects with a tunnel having an outlet to the field above.

The mole is well adapted for the life it leads, for not only are its forefeet armed with powerful digging claws, but its velvet-like fur is embedded vertically in the skin so that it does not become ruffled or clogged with dirt, no matter whether it be brushed backwards or forwards. The creature is a model of industry, and during its foraging expeditions has been known to tunnel through the earth for a distance of 450 times its own length during the course of a night.

Kangaroos are probably the last creatures that one would expect to make nests, but some of the smaller kinds, known as rat-kangaroos, are in the habit of fashioning such shelters. Scraping a depression in the earth beneath a log, or in the midst of thick undergrowth, the animal then collects bunches of grasses, reeds, etc., carrying the material back to the site of the nest, not with its fore-paws, as one might well expect, but with the aid of its prehensile tail. When all is complete, the kangaroo takes a header beneath the pile of litter, covering itself up so as to be out of sight of its enemies.

Another very interesting nest-builder is the platypus, or duckbill, an aquatic mammal found in Southern and Eastern Australia, as well as in Tasmania, but now on the verge of extinction. The animal is remarkable in the fact that the female lays eggs from which her young are hatched, the parent sitting upon the ova during the period of incubation, in the manner of a bird. Chiefly nocturnal in habits, and of a very shy disposition, the platypus makes its headquarters in a burrow excavated in the bank of a stream. Tunnels leading to this home sometimes extend for a length of fifty feet, and entrances are usually situated both below water and above ground.

Constructive ability is revealed to a very high degree in many birds, and when one compares their mental and physical development with that of human beings there is just cause to wonder at the varied accomplishments achieved by the feathered folk with but a minimum of material. Pages could easily be devoted to dealing with the building habits of birds, but we must confine our remarks to a few of the more striking examples.

Let us then take as our first subject the curious hammer-head, or tufted umbre, an African bird about the size of a duck. It is imbued with somewhat original ideas in regard to what should constitute a desirable residence, for instead of being content with a one-roomed establishment, it prefers a bijou flat containing several compartments. Such being the case, the nest must necessarily be of considerable size. Not infrequently it measures more than six feet in diameter, and its strength is so great as to be capable of withstanding the weight of a man sitting on the top. Dome shaped, and composed chiefly of twigs, this "ideal home" consists of three rooms that may be likened to the entrance hall, the day-nursery, and the night-nursery of a human habitation. The latter, which is on the upper floor, is where the young ones are hatched and reared during the early days of their existence; the second or middle room serves as supplementary accommodation when the family grows up and requires more elbow-room, while by standing in the "hall" and looking out of the "front door" the inmates are able to see what is going on outside without exposing themselves unnecessarily to observation.

There is a number of birds which construct mud nests, the swallow and the house martin being familiar examples of such avian masons found in this country, while the oven bird and the grey struthidea may be mentioned among those from foreign climes.

The mud nests of both the swallow and house martin are lined with dried grass and feathers. As a rule they are attached to a wall and placed under the eaves of a house, but it is interesting to note that the former bird has been known to build in a tree, while Gilbert White mentions an individual that for two successive seasons built on the handles of a pair of garden-shears resting in an outhouse, and another that made use of the dried body of an owl, hanging from the roof of a barn, as a support for its nest.

But although the swallow and house martin exhibit such ingenuity in fashioning their homes, the South American oven bird is an even more expert builder. The bird is no larger than a thrush, yet it erects a nest weighing as much as nine pounds, and measuring twelve inches across the widest part. Made of mud, combined with fibrous roots and horsehair, the walls of the structure are half an inch in thickness, and become baked to the hardness of a brick by the heat from the sun. No attempt is made at concealment, the nest usually being situated in a very conspicuous position, such as upon the top of a post, on a large slab of stone, or on the leafless branch of a tree. A small hole serves as an entrance to the home, and inside there is a chamber partitioned off by a wall of hardened clay extending nearly across from one side to the other.

G. Hearn

SWALLOW'S NEST IN A BOX

Under the eaves is the usual and indeed the traditional nesting site of the swallow, but this bird sometimes becomes freakish with regard to its accepted habits. Here is a swallow which built its mud nest in the corner of a packing case

Also composed of mud, and lined with grass, the nest of the grey struthidea, a bird found in Southern and Eastern Australia, is a curious, bowl-shaped erection, open at the top. But the most remarkable fact concerning this tenement is that but a very small portion of the lower and flattened surface is in contact with the bough of the tree upon which it is built, the greater part being entirely unsupported.

Yet another example of a bird that utilises mud in the making of its nest is the hornbill. Selecting a cavity in a tree, the hen lines the bottom with chips of wood, earth and feathers. She then takes up her residence in her "little wooden hut," and settles down to parental duties. The male plasters up the entrance with clay, leaving only a small, slit-like orifice through which his wife may thrust her beak and receive her daily ration of food. Although the prisoner must have a rather trying time whilst thus shut up in such confined quarters, she at least has the satisfaction of knowing that her young ones will be safe from the unwelcome attentions of those creatures that would be only too willing to sup upon them should the opportunity arise.

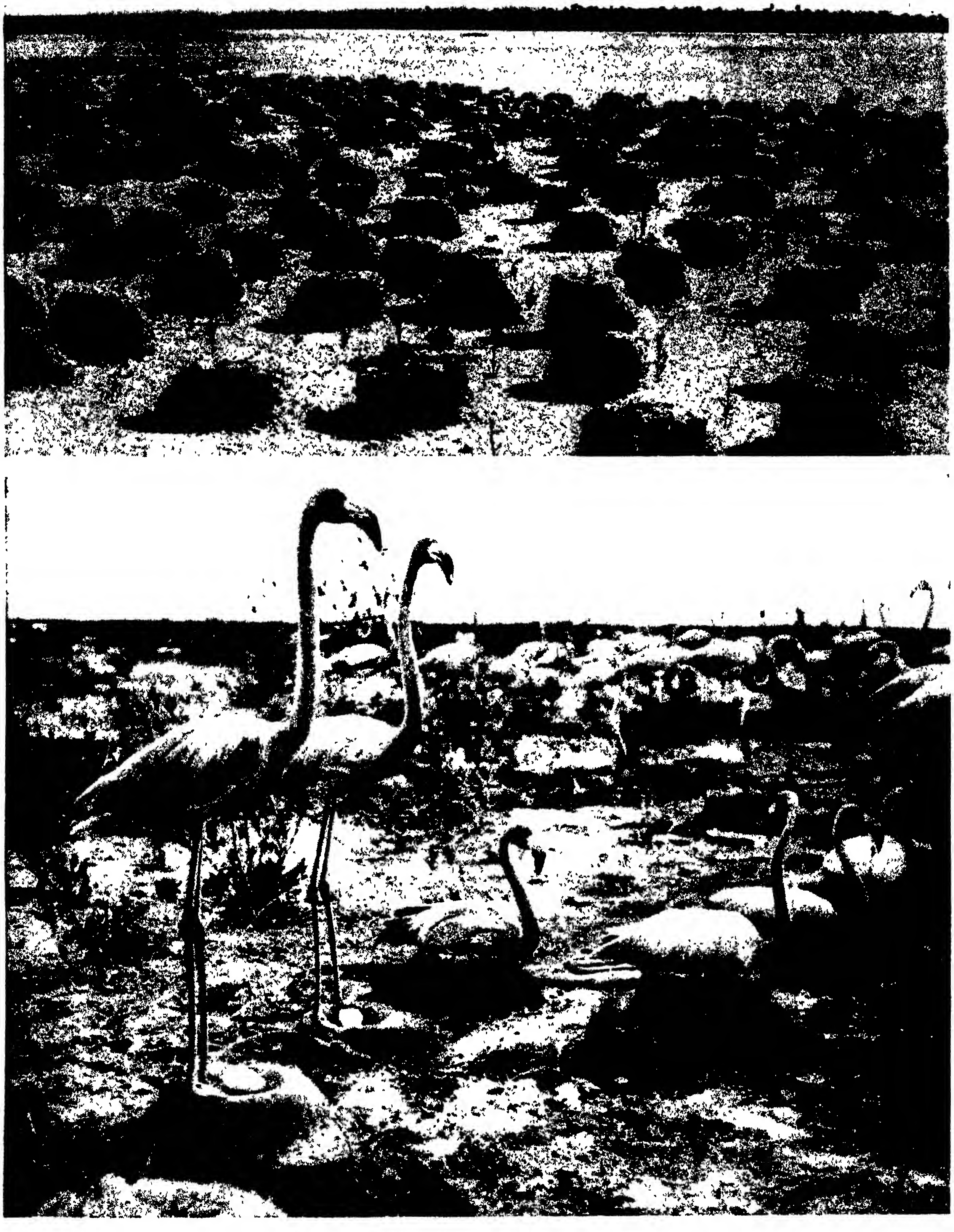
But possibly the strangest of all birds' nests are those of the edible swifts, for they are composed almost entirely of the secretion from the bird's salivary glands, which becomes hardened upon exposure to the air, and looks like isinglass. Shallow, saucer-like structures, and attached to the face of the caves whither the birds resort in considerable numbers, the nests form the chief ingredients of the bird's-nest soup so beloved by Chinese epicures. Owing to the great demand for these dainties, many are destroyed and collected as soon as they are completed, but the industrious workers immediately commence to build new ones, although feathers and other suitable materials are then intermingled with the mucus so as to make up for lost time. In former days it was thought that the substance constituting the nests was yielded by seaweed or some other vegetable matter collected by the birds, but analysis has revealed without a doubt that such is not the case.

VERY notable exponents in the art of nest building are the weaver birds, the tailor birds, and the Australian flower-peckers. The baya, or common weaver bird fashions a retort-shaped structure composed of strips of grass and palm leaves, coconut fibre, and so on, woven together in a most wonderful manner. The lower part of the nest is extended into a long, tubular neck, the extremity of which is left open so as to form an entrance. Attached to the top is a woven cord, the free end being fixed to the bough of a tree, or some other support. The upper part of the entrance-tube is partially screened off internally by a crosswise partition, this being a safety device to obviate the risk of any unfledged birds tumbling down the spout. The cock and hen birds both share in the making of their home, and frequently one will work inside the half-finished nest while the other remains outside, the two passing the ends of the grasses in and out to one another, and pulling them tight.

The sociable weaver birds construct a different type of nest from that of the baya bird. As implied by their name, they are of a very sociable disposition and like to dwell in close proximity to one another. Their communal home is a large, solid, umbrella-shaped structure erected amidst the branches of a tree, the under part being flattened and pierced by numerous holes, each of which denotes the entrance to a nest.

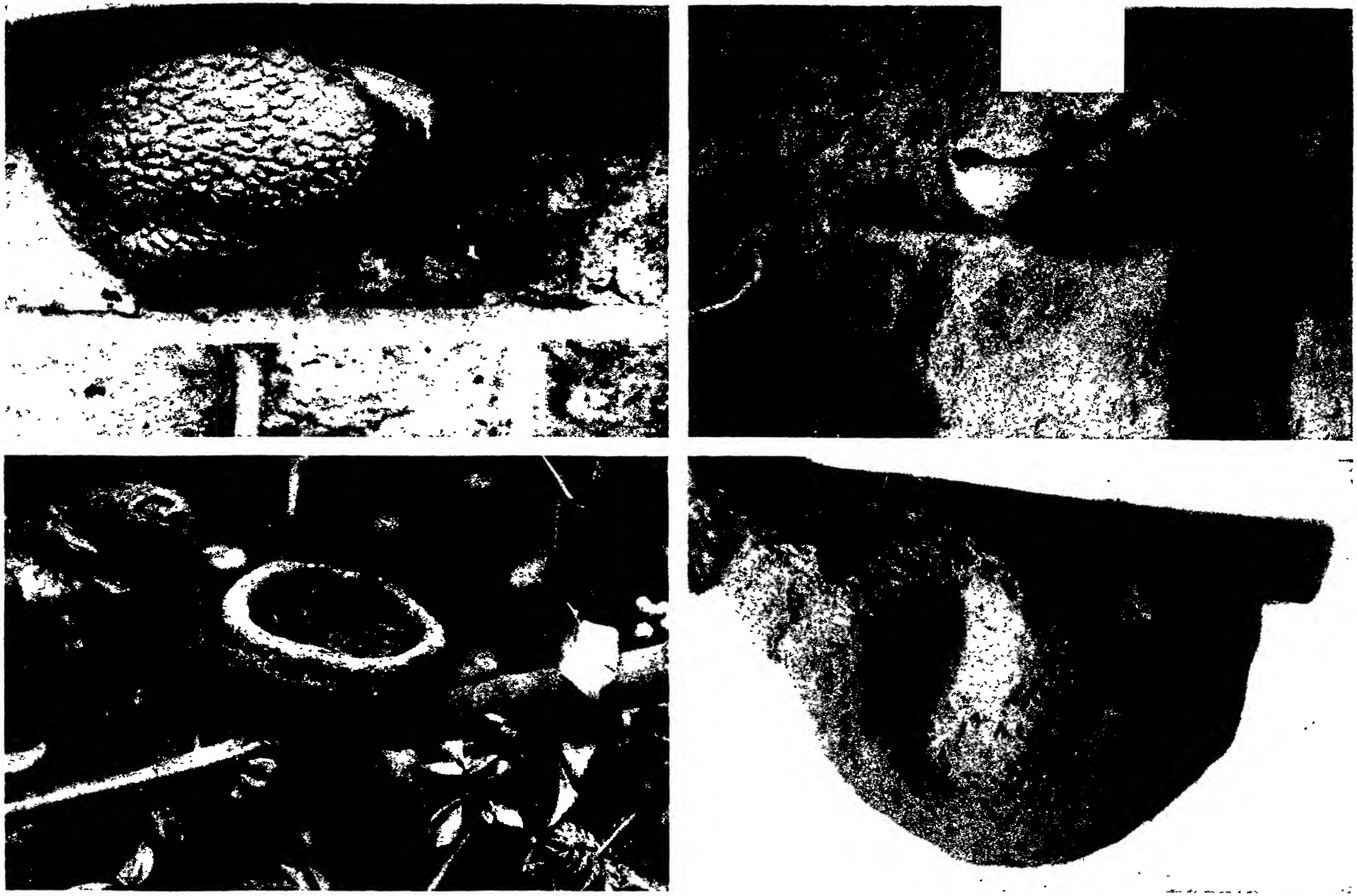
That truth is stranger than fiction is well exemplified in the habits of the tailor bird. Employing its beak as a needle, it actually sews together with vegetable fibre, or the silk from the cocoons of caterpillars, the edges of several adjacent leaves, leaving a small opening at the lower end as an entrance. Within this envelope the proper nest is built with down and fibre.

Equally wonderful are the nests of the flower-peckers. Composed of spiders' webs and the down collected from seed pods, these fairy-like habitations are so soft, and yet so strong, that it is possible to fold them up without their being broken.



QUAINT "MUD-PIE" NESTS OF A COLONY OF FLAMINGOES

The nests of flamingoes vary between a kind of soup-plate shape in those built on the mud flats and marshes, and a cone when constructed actually in the water. Here are some photographs of such colonies of nests as these birds fashion. Below we see some of the quaint parents, and, in the left foreground, two are standing on their nests and the single egg can be seen in the hollow of the nest. Above is a deserted colony in the Bahamas. The nests are made high to avoid being flooded during the rainy season, when they are built



W. S. Berridge

WELL-BUILT HOMES CONSTRUCTED BY CLEVER MASONS AMONG THE BIRDS

One of the most notable of bird masons is the oven bird of South America. Though only about the same size as a thrush, it builds itself a home (bottom left) weighing as much as nine pound and measuring a foot across. This weighty structure is not concealed in any way, but is erected upon the branches of a dead tree or on a rock. The materials are mud, horsehair and roots the walls being half an inch thi k and baked hard by the sun. The Grey Struthidea of southern and eastern Australia makes a bowl-shaped nest out of mud (bottom right). The other photographs are of a martin and its nest under the eaves (top left), and the open, cup-like structure of the swift which builds the nests from which the Chinese make their famous bird's-nest soup.

Quite a different kind of avian constructional work is exhibited by the bower birds, which erect bowers, or playgrounds during the mating season, and before the commencement of nest building.

The gardener bower bird builds a conical-shaped, hut-like edifice of twigs, about two feet in height, and covered with moss. A portion is left open, and in front of this doorway there is a cleared space, bedded with more moss, and decorated with flowers, brightly coloured insects and beetles. These are replaced when they lose their brilliance. The satin bower bird makes its bower in the form of an avenue, embellishing it with shells, flowers, and other brightly coloured objects; while Newton's bower bird erects around the base of two closely adjacent and slender tree-stems a heap of twigs that may in time get piled up to a height of as much as nine feet. It has been noticed that one pillar is always higher than the other, and that only the taller of the two is decorated.

Giving our attention to the fish that make nests, we have in the sticklebacks well-known examples found in British waters. The three-spined stickleback, or "tiddler" collects floating pieces of fibrous roots, straws and grasses, and, transporting them to the bottom of a shallow stream, makes a muff-shaped nest, open at one end, by binding together the material with mucus threads secreted by his kidneys. The female deposits her eggs inside this shelter and then departs, and when the young ones hatch out the male pulls to pieces the roof of the structure, thereby converting it into a kind of cradle.

Very similar is the nest of the ten-spined stickleback, although it does not rest upon the ground, but is woven around and supported by the stems of water plants; while that of the fifteen-spined stickleback, or "marine adder," is a pear-shaped structure composed of fronds of seaweed which the male binds together with the aid of a pliable thread, exuded from his mouth, that quickly hardens in the water.

Another curious form of nest is that made by the tentacle fish. It builds in the midst of the gulf-weed of the Sargasso Sea, pieces of seaweed being joined to one another by a pasty secretion yielded by the fish, and the large, grape-like bunches of eggs laid by the female being suspended therefrom.

The fresh-water fish from the United States, known as the bowfin, makes a nest amidst thick reeds and aquatic vegetation. The male bites through and removes the stems of reeds and plants, thereby clearing a circular space with a passage-way leading to the open water beyond. On the floor of this prepared area he scoops out a saucer-shaped depression to a depth of about eight inches, and with a diameter of several feet, remaining in the privacy of this sanctum for the arrival of the females to lay their eggs.

But the most remarkable of fishes nests are probably those of the paradise fish and the fighting fish. The males blow bubbles from their mouths and these rise to the surface of the water and form a mass of froth. Each nest is about one quarter of an inch in depth, and covers an area of about six inches across the widest part. When these floating abodes are finished, the females take up their position beneath and liberate their spawn, the eggs being so light that they rise upwards and settle amidst the froth. In this situation the young ones hatch out, being guarded by the males.

The only other creatures that make bubble nests are certain kinds of frogs. Some of the piping frogs excavate a small hole in the ground, and then fill the cavity with a frothy mixture that keeps the spawn moist; while the nest of White's tree frog is composed of bubbles, and floats upon the surface of the water. Very similar are the habits of a flying frog found in Japan, for the jelly-like substance with which the eggs are enclosed is beaten up into froth by the creature's hind legs.

Crocodiles and alligators must be added to our list of nest builders. The female of the Mississippi alligator makes a large mound of leaves, twigs, and grasses, the heap measuring as much as ten feet in diameter, and several feet in height. She deposits her eggs amidst this material, covering them up with moist vegetation, the decaying of which generates a considerable amount of heat and hatches the young.

But the nest of the crocodile is a much simpler affair than that of the alligator, and consists merely of a depression scooped out in the sandy soil. From forty to sixty eggs are laid therein, after which they are covered with sand and usually left to be hatched by the heat from the rays of the sun. Sometimes, however, the female will assist in the process of incubation by resting upon the place beneath which her eggs repose.

Of the lower forms of life that follow the occupation of a mason or builder, brief mention must be made of the corals, bees, wasps, ants, and termites.

It is not always realized that the hard, stony substance of commerce called coral is nothing more than a deposit of carbonate of lime extracted by the living creatures from the sea wherein they dwell, the organisms themselves being soft-bodied and jelly-like. Some corals are separate and of simple structure, but others, as exemplified by the reef-builders, are what is termed compound—that is to say, they increase from the parental stock by a continual process of budding, each new individual being connected by tissue to another, so that the entire colony, no matter how large it be, may be likened unto a single living mass which possesses innumerable mouths and digestive organs.

In the Pacific and Indian Oceans, far distant from land, large masses of coral arise from the depths to the level of the water, and often extend for a distance of many miles. These reefs consist of living coral at their upper and outer surfaces, the inner and lower parts of the structures being dead. Corals are frequently most beautifully coloured, those that constitute the Great Barrier Reef of Australia, for instance, varying in tint from red, purple and violet to emerald and orange

Martin Duncan

TRAP-DOOR SPIDER'S DWELLING

Certain spiders called, from their building habits, trap-door spiders, make a burrow in the earth and shore up the walls with layers of silk. The entrance is provided with a trap door or lid, built of earth and provided with a hinge of silk.

The majority of ants make nests. One kind found in South America collect and carry in their jaws fragments of earth which they deposit on the branch of a tree and fashion into a home perforated by tunnels leading to dwelling chambers. The latter are lined with a papier-mâché-like substance consisting of masticated wood-dust mixed with a tenacious fluid that flows from the ants' salivary glands. The exterior of the nest is sown by the tiny workers with the seeds of various plants. These germinate and throw out leaves, the foliage then acting as a screen.

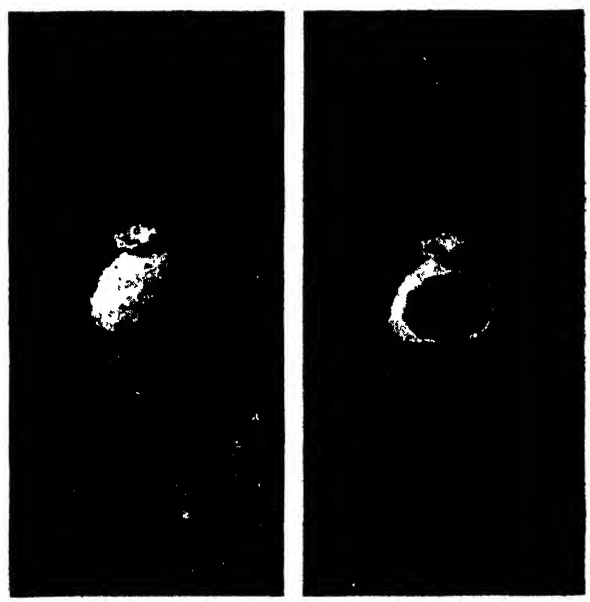
Another species of ant, from Central America, makes a nest within the large thorns protecting the branches of acacia trees; while the red or spinning ants join together a number of leaves, the edges of which are made to adhere to one another with a silky thread which is produced by the grubs just prior to their becoming transformed into the chrysalis stage.

The wood ants, the largest species found in this country, fashion a nest that takes the form of a heap of small fragments of sticks and vegetable substances, honeycombed with galleries and chambers; while the black garden ant, with which we are so familiar, often adds to the extent of its underground home by gnawing away the interior of dead branches or rotting woodwork, the material removed being chewed up into a "paper" employed in the erecting of walls and supports.

WITH the so-called white ants which, although very ant-like in appearance, are not ants, but should more properly be spoken of as termites, we come to some atoms of life that erect enormous nests of earth and wood-pulp, mixed with saliva, that sometimes project above the level of the ground to a height of twenty or thirty feet. The walls are extremely hard, and the entrances to the nests are always situated underground.

The bees and wasps exhibit remarkable skill as builders, and the six-sided cells of wax that many fashion for the storage of their food and for residential purposes are familiar to all.

The mason wasps and the potter wasps make their homes of earth. Two species of the former found in Britain excavate tunnels in sandy banks, the material removed being erected around the mouths of the abodes into projecting and tubular spouts that help to prevent the ingress of another kind of wasp that seeks to lay its eggs in the nests of the rightful owners.



Hugh Main

NEST OF A MUD-WASP AND ITS CONTENTS

On the left is a view of a mud wasp's nest shaped rather like a bag tied at the top. On the right we see the nest opened to show the developing wasp grub inside, and a caterpillar provided by the parent for the growing grub's food.

END OF SECOND VOLUME